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RESEARCH NOTES

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INSTRUCTIONS TO AUTHORS

1. Papers dealing with the flora and vegetation of Western Australia will be considered for publication.

2. Style should follow that of a recent issue. All *illustrations*, including drawings, maps, graphs, and photographs, should follow a single, numbered sequence in each paper. They should be submitted in their final size for printing (maximum dimensions 15 cm x 24 cm including space for caption). *References* should quote titles of periodicals in full. Authors should suggest a *short title* for page headings.

3. Papers will be reviewed by an editorial committee. Contributions should be addressed to The Editor, Research Notes, Western Australian Herbarium, Department of Agriculture, George Street, South Perth, Western Australia 6151.

4. VOUCHER SPECIMENS: It is suggested that botanical names central to the objective of the paper be supported by specimens deposited in a recognized herbarium and that the institution be cited in the paper. It is desirable to quote, in the paper, numbers identifying specimens whose determination is uncertain. An explanatory note on the subject is available from the Editor.

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WESTERN AUSTRALIAN HERBARIUM RESEARCH NOTES

No. 2: 1-21

PRELIMINARY VEGETATION SURVEY OF STAR SWAMP AND VICINITY, WESTERN AUSTRALIA

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ABSTRACT

Star Swamp and the adjacent bushland are Perth metroplitan remnants of the once extensive natural vegetation of the Swan Coastal Plain. They presently provide areas for school nature study programmes, a wildland recreational facility and serve as refugia for native plants and animals. This study was designed to provide a floristic survey of the area, a description of the major plant communities and insights into the relationships between these communities and some environmental factors.

INTRODUCTION

Star Swamp and its surrounding bushlands are located in the Perth metropolitan suburb of North Beach, Western Australia (31°51'S, 115°45'E). Bounded by North Beach Rd., Marmion Ave., Beach Rd., and Hope St., the area provides a refuge for native animals and plants in a region of suburban development (Fig. 1). Application for re-zoning the crown land for residential use has prompted a group of environmentalists and concerned citizens to request that the area be preserved and managed as a flora and fauna reserve (Anon., 1976). The area has been used for nature study by nearby schools, a wildland recreational facility, and the occasional use by trail-bike riders. The area contains numerous sand tracks which restrict its aesthetic quality, but has a variety of vegetational communities and a diversity of plants and animals characteristic of the Swan Coastal Plain.

The vegetation was once part of an extensive system of wetland swamps and adjacent stabilized communities of the Spearwood Dune soils of the Swan Coastal Plain (Seddon, 1972). Most of the wetland communities of the Perth metropolitan area have already been lost to urban development. These originally formed a vegetation type which made up only a very small portion of south-western Australia (Riggert, 1966). The Tuart Woodland and Banksia Woodland communities of the Swan Coastal Plain were once also more widely spread, but today, most of these areas have been lost to agriculture and

Fig. 1. Aerial photograph of the Star Swamp and adjacent bushland and study area of North Beach, Western Australia.

urbanization (Seddon, 1972).

The objectives of the current study were to determine the major plant communities of the area, to characterize these communities in terms of density, frequency and cover of the major species, and to study the relationship between these major plant communities and some factors of the physical environment.

METHODS

A reconnaissance of the study area revealed that the vegetation could be partitioned into four major communities based on plant growth form and identity of the most conspicuous species. These were designated Paperbark Woodland, Tuart Woodland, Banksia Woodland, and Open Heath (Fig. 2). Within each community the dominant trees were sampled for frequency and cover. Canopy cover density was sampled using a densiometer (Lemmon, 1956). Cover density of living and dead canopy was recorded separately for each contributing species. One to three line transects were located arbitrarily within each community to sample understorey species cover. Average species cover was determined from ten 2 x 2 m quadrats located along each transect using a stratified random procedure. Frequency was determined as the percentage of quadrats containing a given species. Nomenclature for the species recorded follows Beard (1970), Blackall and Grieve (1974), and Grieve and Blackall (1975). Water quality at Star Swamp was assessed from samples of surface water obtained 8 September 1977 from the main pond and from the street run-off drain. Measures of phosphate phosphorus, organic phosphorus, ammonia, nitrogen, nitrate nitrogen and Kjeldahl nitrogen were made according to standard laboratory procedures (Anon., 1971).

Soil conditions of each plant community were determined from one to three soil profile excavations of each vegetation transect site to a maximum depth of 2 m. A minimum of two replicate samples from each horizon were described in terms of colour (Munsell Color Company, 1954), soil texture (Bouyoucos, 1936), soil moisture at field capacity, soil pH and conductivity. Soil pH and conductivity were measured with glass electrodes (Bear, 1964).

RESULTS

A total of 209 species representing 157 genera and 55 families of plants was recorded for the 100 ha study area surrounding Star Swamp (Appendix 1). Of this total, 75 were native to Western Australia, the remainder were alien and most of Mediterranean or South African origin. Herbaceous species predominated with 123 species. Of the 78 species of woody plants recorded, 13 were trees. The most common family was Fabaceae (19 species) followed by the Proteaceae (16), Asteraceae (15), Orchidaceae and Poaceae, each with 13 species and Liliaceae with 12 representatives.

The tree growth form was a major criterion in the arbitrary separation of the plant communities of the study area. Canopy cover density of these communities generally decreased with increasing distance from the pond (Table 1). The Paperbark Woodland canopy stratum was dominated by *Melaleuca rhaphiophylla* (Swamp Paperbark) with *Eucalyptus gomphocephala* (Tuart) an important associate. Of the contribution by Tuart, however, only 46% was

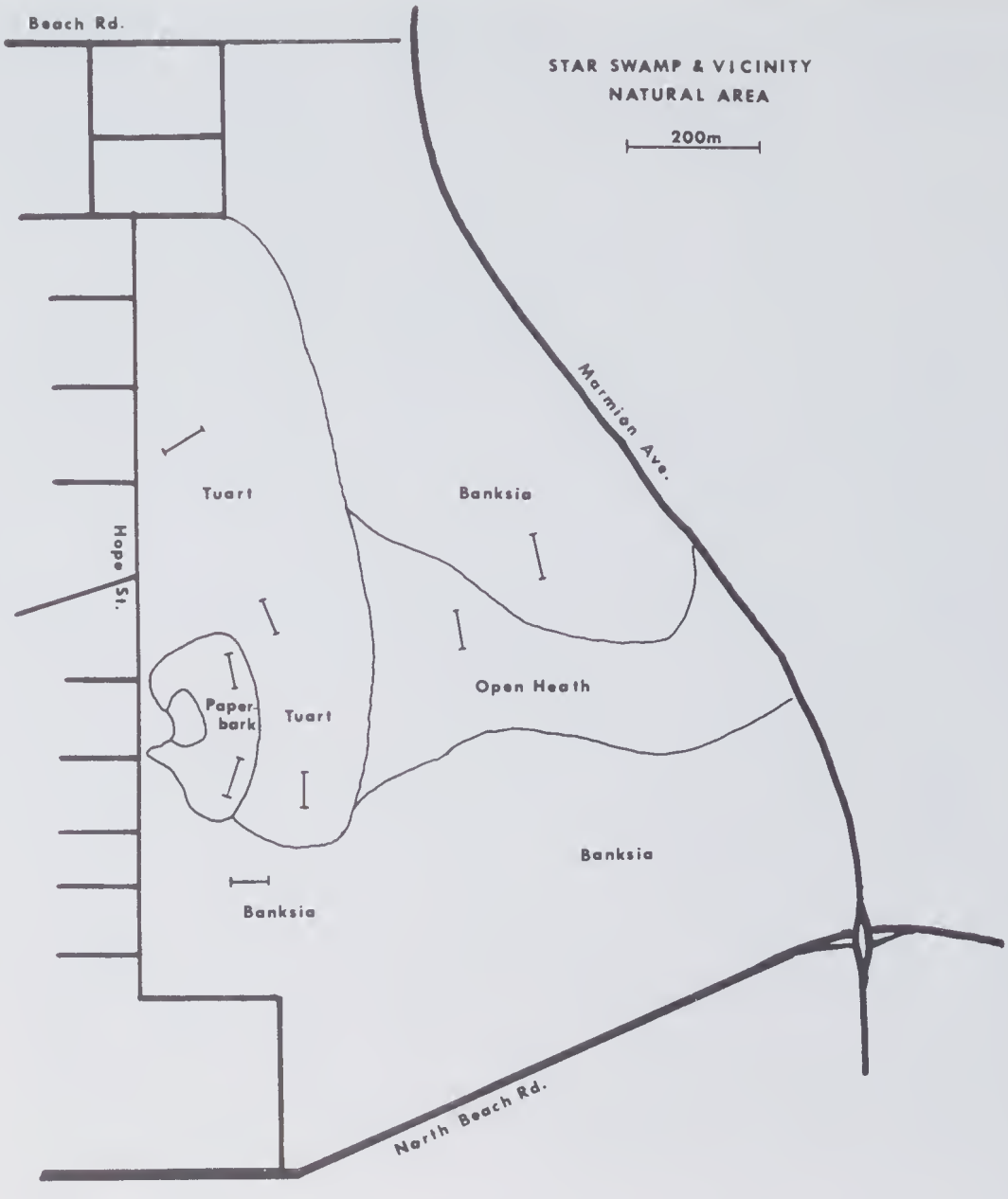

Fig. 2. Map of study area showing the distribution of natural plant communities and locations of the vegetation sampling transects.

living tissue. The Paperbark canopy, on the other hand, was recorded almost entirely as living tissue. From the 50% canopy cover recorded in the Paperbark Woodland community, canopy cover dropped to 33% in the Tuart community. Tuart dominated the canopy density in the samples with *Eucalyptus marginata* (Jarrah) and the occasional *Banksia grandis* (Bull Banksia) and *Eucalyptus calophylla* (Marri) recorded. The 75% living tissue value for Tuart in this community indicated an improvement over the status of Tuart individuals in the Paperbark Woodland. Cover density values for the Banksia Woodland were dominated by three Banksia species *(Banksia menziesii, B. attenuata,* and *B. prionotes)* with minor contributions by Tuart and *Casuarina fraserana* (Sheoak). The Open Heath community did not have a canopy dominated by tree growth forms.

Table 1. Canopy cover density percentages for living and dead tissue for the major tree species of the study area.

SPECIES	PAPERBARK		TUART		BANKSIA	
	Alive	Dead	Alive	Dead	Alive	Dead
Melaleuca rhaphiophylla	31.7	4.3	-	-	-	-
Eucalyptus gomphocephala	6.4	7.6	19.5	6.5	2.6	1.4
Eucalyptus marginata	-	-	4.8	0.2	-	-
Banksia (4 species)	-	-	1.0	1.0	16.4	4.6
Casuarina fraserana	-	-	-	-	1.0	0.0
TOTALS	38.1	11.9	25.3	7.7	20.0	6.0

Shrub and herbaceous life-forms contributed to the vegetation structure of the three tree-form dominated plant communities and represented the dominant life-form in the Open Heath regions (Table 2). Understorey species of the Paperbark Woodland tended to be restricted to this community, while a progression of species was found in the remaining communities. Several species were found in the sampling transects of all three upland communities. Ground cover in the Paperbark community was dominated by the sedges *Baumea juncea* and *Gahnia trifida*, and by *Sporobolus virginicus* (Sand couch grass). Of the plant cover, 98% was contributed by species native to the region. Most common species of the Tuart understorey were *Xanthorrhoea preissii* (Blackboy), the shrubs *Jacksonia sternbergiana* and *Pelargonium capitatum* (Wild geranium), and the herbaceous species *Conostylis candicans*, *Ehrharta longiflora* (Veldt grass), *Freesia refracta*, *Lagurus ovatus* (Hare's-tail grass), *Romulea rosea* (Guildford grass) and *Petrorhagia* sp. (Proliferous pink). Percentage plant cover resulting from introduced species was very large at 70%.

In the Banksia community, elements of the understorey included *Xanthorrhoea preissii*, *Jacksonia sternbergiana* and *Dryandra nivea* (Dwarf dryandra). The weedy introduced species *Ehrharta longiflora*, *Avena barbata* (Oat grass), *Hypochoeris glabra* (Smooth cat's-ear) and *Romulea rosea* were also common. The percentage of plant cover from introduced species was 36%. Bare ground was greatly increased in the Banksia community when compared to the two previous communities. Bare ground was also a common characteristic of the Open Heath community. The common shrubs of the Heath sample included *Acacia cyclops*, *Lechenaultia linarioides* (Yellow lechenaultia) and *Grevillea thelemanniana* (Spider-net grevillea). The weedy introduced species, *Ehrharta longiflora*, *Hypochoeris glabra*, *Ursinia anthemoides* and *Lupinus cosentinii* (Sand-plain lupin), were common between the native shrub species. The introduced species have made large inroads into this community with a total of 53% of vegetative cover being accounted for by alien species.

The samples of the water from the inlet drain from the housing development to the west of Star Swamp were generally higher in nutrients measured than samples taken from the main pond (Table 3). Using as indicators, the levels of nitrogen and phosphoros in tables from Sakamota (1966) (cited in Vollenweider, 1968), Star Swamp is presently classified as a meso-eutrophic lake.

Table 2. Frequency occurrence and percentage cover (in parentheses) of understorey species. An asterisk marks introduced species.

SPECIES	Paperbark	Tuart	Banksia	Heath
Baumea juncea	71 (28)			
Sporobolus virginicus	76 (24)			
Gahnia trifida	65 (18)			
Samolus repens	53 (3)			
Centella asiatica	41 (2)			
*Freesia refracta**		67 (14)		
*Lagurus ovatus**		40 (9)		
*Cerastium glomeratum**		40 (3)		
Medicago sp.*		43 (2)		
Dichopogon strictus		36 (2)		
*Vicia sativa**		36 (1)		
Petrorhagia sp.*		30 (4)		
Macrozamia riedlei		13 (1)		
Xanthorrhoea preissii		40 (8)		
Jacksonia sternbergiana		47 (5)		
Conostylis candicans		60 (2)	38 (2)	
*Silene gallica**		33 (3)	62 (1)	
*Romulea rosea**		30 (4)	56 (3)	
Sowerbaea laxiflora		23 (1)	31 (1)	
Hibbertia hypericoides		20 (1)	56 (3)	
Acanthocarpus preissii		7 (1)	31 (1)	
*Avena barbata**		10 (0)	67 (3)	
*Ehrharta longiflora**		87 (12)	88 (3)	100 (19)
*Pelargonium capitatum**		63 (7)	38 (1)	25 (2)
Hardenbergia comptoniana		33 (3)	19 (1)	50 (3)
Gladiolus sp.*		13 (0)	81 (2)	75 (2)
Anagallis arvensis var. *caerulea**		7 (0)	50 (1)	50 (3)
Dianella revoluta		17 (1)	9 (1)	50 (3)
*Ursinia anthemoides**		10 (0)	38 (3)	100 (4)
Dryandra nivea			50 (7)	
*Hypochoeris glabra**			50 (4)	100 (6)
Grevillea thelemanniana			19 (1)	75 (4)
Burchardia umbellata			50 (1)	50 (2)
Acacia cyclops				100 (15)
Lechenaultia linarioides				100 (9)
*Lupinus cosentinii**				100 (6)
Others	- (8)	- (14)	- (19)	- (4)
Open Water	1 (16)	- --	- --	- --
Bare Ground	- --	- (2)	- (24)	- (18)
Total Vegetative Cover	84%	98%	76%	82%

Table 3. Parameters of water quality of the drain inlet and from the main pond of Star Swamp. Water sampled 8th September, 1977.

Nutrient (µg/l)	SITE	
	Drain	Main Pond
PO_4-P	25	8
Organic P	43	40
Total P	68	48
NH_3-N	312	345
NO_3-N	10	12
Kjeldahl N	2160	2030

Assessment of the edaphic conditions present in each vegetation community revealed major differences between the Paperbark Woodland and the other three designated communities (Table 4). The fluctuating water table of the Paperbark region has had a major effect on soil development. Soil colours were very dark, indicating that the profile contains large amounts of organic matter. Organic matter percentages also bore this out as did the capacity of the soil to hold water against the pull of gravity. The relatively large silt and clay fractions and the alkaline pH values probably reflect poor leaching due to the high water table in the area. Soil profile conditions in the remaining plant communities were generally comparable except for slightly more alkaline pH values for the Tuart soil horizons and the outcropping limestone of the shallower soils of the Open Heath.

DISCUSSION

The establishment, development and survival of a plant community in any area is determined principally by the climate, soil properties and the past history of the potential habitat (Specht, 1960).

The areas of natural bushland occurring within urbanized regions however, are also subject to increased pressures through man's activities. Indicative of this is the nutrient status of the water of Star Swamp which is comparable to the much larger Lake Monger (Atkins *et al.*, 1977) and Lake Joondalup (Congdon and McComb, 1976), two lakes within the Perth metropolitan area. Loch McNess of Yanchep National Park, 50 km to the north of Perth, is much less eutrophic than the metropolitan lakes (Atkins *et al.*,

Table 4. Soil variable data for profiles of the study area

Profile Depth (cm)	Colour	Texture (%) Sand	Silt	Clay	Organic Matter (%)	Soil Field Capacity (%)	pH	Conductivity (x 10^{-3} µmhos.cm^{-1})
Paperbark Woodland:								
0 - 15	Very dark grey	85	12	3	30.8	195	7.9	1.08
15 - 30	Grey	82	14	4	13.9	111	7.9	0.66
30 - 60	Black	92	8	0	41.3	364	7.8	0.73
Tuart Woodland:								
0 - 2	Very dark grey	98	2	0	7.8	39.0	7.6	2.40
2 - 20	Yellowish brown	99	1	0	2.8	25.2	7.6	0.97
20 - 40	Brown	98	2	0	1.6	23.0	7.6	0.79
>40	Dark grey brown	98	2	0	0.8	19.6	7.6	0.47
Banksia Woodland:								
0 - 1	Black	98	2	0	16.8	67.8	7.4	0.96
1 - 20	Reddish grey	99	1	0	5.6	22.2	7.1	0.21
20 - 40	Reddish brown	100	0	0	2.3	21.4	7.1	0.15
>40	Brownish yellow	100	0	0	1.2	20.5	7.1	0.09
Heath:								
0 - 1	Black	97	3	0	11.1	29.2	7.6	0.20
1 - 10	Dark grey	96	4	0	3.6	26.7	7.2	0.05
10 - 35	Brown	98	2	0	2.1	25.9	7.2	0.04
>35	Yellowish brown	98	2	0	2.7	25.1	7.1	0.04

1977). The present concentration of nutrients in the inlet drain at Star Swamp indicates that the main pond will probably become more eutrophic with time unless appropriate action to reduce nutrient input into the lake is undertaken. With increased nutrient concentration in the small volume of Star Swamp, the possibility of algal booms is increased and a resulting depletion of oxygen levels would have severe effects on the aquatic life in the pond. Diversion of run off from developed areas and maintenance of the existing natural vegetation in the catchment would help to prevent further eutrophication of the swamp.

Within the Paperbark fringing Star Swamp, the water-satuarated soil profile, high organic matter content and relatively high concentrations of silt and clay particles combine to present a severe habitat which only a relatively few species can tolerate (Bergman, 1959). species intolerant of the low oxygen concentrations of the rooting zone and changing water levels are excluded from this zone. Tuart individuals in this zone are dying probably due to a general increase in water level noted over the past 25 years. Burton (1976) reports that the average level of Star Swamp has risen approximately 1 m since 1950 and attributes this change to the clearing of land and the subsequent residential development on the western side of the swamp. General observations of numbers of dead stems of Paperbark and Tuart within the present limits of inundation suggest that the Paperbark community has greater ecological capacity to tolerate these past changes. With further land clearing, however, and a continued increase in water levels, the future of this community could be in doubt.

Surrounding the Paperbark community, the lower slopes of the drainage area are dominated by the Tuart Woodland. Tuart has been reported to be restricted to alkaline limestone soils on the western Swan Coastal Plain where it typically develops nearly pure stands (Gardner, 1944). While Tuart is the major canopy dominant in the zone above the region of periodic inundation, introduced species contribute the majority of the ground cover percentage. These species include *Freesia refracta*, *Ehrharta longiflora*, and *Pelargonium capitatum*. The dominance of the understorey by introduced species is indicative of disturbance of the habitat. Although it is unclear whether freedom from man-made disturbance will result in a re-establishment of the native species, it seems clear that increased disturbance will result in an increased population of alien species.

The Banksia Woodland community in general, occurs in areas of the study site topographically above the Tuart Woodland, and is distinguished by less alkaline soils. The absence of Banksia Woodland dominants in the Tuart region could be due to intolerance of the more alkaline conditions. The less dense canopy of the Banksia community is not reflected in the proportion of alien species in the understorey compared, for example, with the Tuart community. This may, however, have resulted from a recent fire in the area of one of the Banksia Woodland sampling transects. It is likely that frequent burning and continued use of the sand tracks will lead to an increase in the ratio of introduced to native species.

Limestone outcropping is the most obvious physical characteristic of the Open Heath habitat, distinguishing it from areas harbouring the Tuart and Banksia communities. The shallow soils and the effects of wind, as evidenced by the wind-pruned appearance of the shrubs, probably indicate that the ridge habitat may be too dry for the arborescent species. *Acacia cyclops*, a common species of the coastal dune community (Smith, 1973), is well adapted to the shallow sandy soils and drying winds of the ridge in the Star Swamp study area and contributes a major share of the plant cover of the Open Heath community. Bare soil is a common attribute of both the Open Heath and the Banksia Woodland communities. These bare areas, accentuated

by human disturbance, present ample opportunity for further invasions by the already established alien herbaceous species *Ehrharta longiflora*, *E. calycina*, *Ursinia anthemoides*, and *Hypochoeris glabra*.

Star Swamp and the adjacent plant communities are remnants of natural bushland in the Perth metropolitan area which, although degraded by urban development, provide areas for educational and recreational use. Rapid eutrophication of the pond and the encroachment of introduced weedy species into the native plant communities can be slowed through a combined process of developing a basic understanding of the relationships of the biological and physical factors of the ecosystem and a plan of management. The management of the area to best provide benefits for both the human and natural environment should be the major goal for the future. The Perth metropolitan area has very few remaining natural bushlands. The preservation of Star Swamp and its environs as a flora and fauna reserve would provide benefits to all citizens of the Perth metropolitan area.

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APPENDIX 1

VASCULAR PLANTS OF STAR SWAMP

KEY:

a) Habitat -
- P = Paperbark Woodland
- T = Tuart Woodland
- B = Banksia Woodland
- H = Open Heathland

b) Life form -
- C = creeper or climber
- H = herbaceous, non-woody plant
- P = plant of palm-like habit

S = shrub
T = tree

c) Origin - (n) = native
(i) = introduced

Name	Form & Origin	Habitat			
		P	T	B	H
ZAMIACEAE: Zamia palm family					
Macrozamia riedlei (Gaud.) C.A. Gardn. Zamia palm	P(n)		+	+	
ANGIOSPERMAE: Monocotyledoneae					
TYPHACEAE: Cat-tail rush family					
Typha orientalis Presl.	H(n)	+			
POTAMOGETONACEAE: Pondweed family					
Potamogeton pectinatus Linn. Fennel pond weed	H(n)	+			
JUNCAGINACEAE: Arrow grass family					
Triglochin procera R.Br. Water ribbons	H(i)	+			
Triglochin striata Ruiz & Pav. Streaked arrowgrass	H(i)	+			
POACEAE: (= Gramineae) Grass family					
Avena barbata Link. Bearded oatgrass	H(i)		+	+	+
Briza maxima L. Quaking grass	H(i)	+	+	+	+
Briza minor L. Lesser quaking grass	H(i)		+	+	
Bromus diandrus Curt. Great brome	H(i)		+		+
Cynodon dactylon (L.) Pers. Couch grass	H(i)	+	+		
Ehrharta calycina Sm. Perennial veldt grass	H(i)	+	+	+	+
Ehrharta longiflora Sm. Annual veldt grass	H(i)	+	+	+	+
Gastridium phleoides (Nees & Meyen) C.E. Hubbard Nit grass	H(i)	+			
Hordeum leporinum Link. Barley grass	H(i)	+			
Lagurus ovatus L. Hare's-tail grass	H(i)		+	+	+
Sporobolus virginicus (L.) Kunth. Sand couch	H(n)	+	+		
Stenotaphrum secundatum (Walt.) Kunth. Buffalo grass	H(i)	+			

Name	Form & Origin	Habitat			
		P	T	B	H
Stipa variabilis Hughes Spear grass	H(n)		+		
CYPERACEAE: Sedge family					
Baumea juncea (R.Br.) Palla.	H(n)	+			
Carex preissii Nees	H(n)		+		
Gahnia trifida Labill. Coast saw sedge	H(n)	+			
Lepidosperma gracile R.Br.	H(n)		+	+	
Mesomelaena stygia (R.Br.) Nees Semaphore sedge	H(n)			+	+
Schoenus trachycarpus F. Muell. Rough-fruited bog rush	H(n)		+	+	+
Scirpus maritimus L. Marsh club rush	H(n)	+	+		
Scirpus nodosus Rottb.	H(n)	+			
Scirpus validus Vahl.	H(n)	+			
Tetrariopsis octandra (Nees) C.B. Clarke	H(n)		+		+
RESTIONACEAE:					
Loxocarya sp.	H(n)			+	
JUNCACEAE: Reed family					
Juncus kraussii Hochst	H(n)	+			
LILIACEAE: Lily family					
Arthropodium capillipes Endl.	H(n)		+		
Burchardia umbellata R.Br. Milkmaids	H(n)		+	+	+
Caesia parviflora R.Br. Pale grass lily	H(n)		+	+	+
Corynotheca micrantha (Lindl.) Macbride	H(n)		+	+	+
Dianella revoluta R.Br. Spreading flax lily	H(n)		+	+	+
Dichopogon strictus (R.Br.) J.G. Baker Chocolate lily	H(n)		+		
Laxmannia sp.	H(n)			+	+
Sowerbaea laxiflora Lindl. Vanilla lily	H(n)		+	+	+
Thysanotus asper Lindl. Hairy fringe lily	H(n)		+	+	
Thysanotus patersonii R.Br. Twining fringe lily	C(n)		+	+	+
Thysanotus sparteus R.Br. Fringe lily	H(n)		+	+	+
Tricoryne elatior R.Br. Yellow autumn lily	H(n)		+	+	+
XANTHORRHOEACEAE: Grass tree family					
Acanthocarpus preissii Lehm.	C(n)		+	+	

Name	Form & Origin	Habitat			
		P	T	B	H
Lomandra spp. (probably 3 spp.) Mat rush	H(n)	+	+	+	+
Xanthorrhoea preissii Endl. Black boy, Grass tree	P(n)	+	+	+	
HAEMODORACEAE: Kangaroo paw family					
Anigozanthos humilis Lindl. Cat's paw	H(n)			+	
Anigozanthos manglesii D. Don. Common kangaroo paw	H(n)			+	
Conostylis aculeata R.Br.	H(n)		+	+	+
Conostylis candicans Endl.	H(n)		+	+	+
Haemodorum paniculatum Lindl.	H(n)		+	+	+
IRIDACEAE: Iris family					
Chasmanthe aethiopica (L.) N.E. Br. *(=Antholysa aethiopica* L.) African Cornflag	H(i)		+		
Ferraria sp.	H(i)	+			
Freesia refracta (Jacq.) Klatt Freesia	H(i)	+	+		
Gladiolus sp. Gladiolus	H(i)		+	+	+
Homeria collina (Thunb.) Vent. One-leaved cape tulip	H(i)	+		+	+
Orthrosanthus laxus (Endl.) Benth. Blue day lily	H(n)			+	
Patersonia occidentalis R.Br. Purple flag	H(n)			+	+
Romulea rosea (L.) Eckl. Guildford grass	H(i)		+	+	+
Sparaxis grandiflora Ker.	H(i)	+			
ORCHIDACEAE: Orchid family					
Caladenia deformis R.Br. Blue fairy orchid	H(n)		+		
Caladenia filamentosa R.Br. Spider orchid	H(n)			+	
Caladenia flava R.Br. Primrose or Cowslip orchid	H(n)			+	
Caladenia huegelii Reichb.f. Green spider orchid, King orchid	H(n)	+			
Caladenia latifolia R.Br. Pink fairies	H(n)		+	+	+
Caladenia menziesii R.Br. Rabbit orchid	H(n)		+		
Caladenia patersonii R.Br. White spider orchid	H(n)		+	+	
Diuris longifolia R.Br. Donkey or Wallflower orchid	H(n)		+	+	+

Name	Form & Origin	Habitat			
		P	T	B	H
Lyperanthus nigricans R.Br. Red beak orchid	H(n)			+	
Microtis sp.	H(n)	+			
Prasophyllum sp. Leek orchid	H(n)	+	+		
Pterostylis scabra Lindl. var. *robusta* Green shell orchid (Rog.) A.S. George			+		
Pterostylis vittata Lindl. Banded greenhood	H(n)		+	+	
Dicotyledoneae					
CASUARINACEAE: Sheoak family					
Casuarina fraserana Miq. Sheoak	T(n)			+	
Casuarina humilis Otto & Dietr. Dwarf casuarina	S(n)			+	+
PROTEACEAE: Banksia family					
Banksia attenuata R.Br. Narrow-leaved banksia	T(n)			+	
Banksia grandis Willd. Bull banksia	T(n)		+		
Banksia menziesii R.Br. Menzies' banksia	T(n)			+	
Banksia prionotes Lindl. Acorn banksia	T(n)			+	
Dryandra nivea R.Br. Dwarf dryandra	S(n)		+	+	
Dryandra sessilis (R.Br.) Druce Parrot bush	S(n)		+	+	
Grevillea crithmifolia R.Br.	S(n)		+		
Grevillea thelemanniana Hueg. Spider-net grevillea	S(n)		+	+	+
Grevillea vestita (Endl.) Meisn.	S(n)			+	
Hakea prostrata R.Br. Harsh hakea	S(n)		+	+	
Persoonia saccata R.Br. Snottygobble	S(n)		+		
Petrophile linearis R.Br. Pixie mops	S(n)		+	+	
Petrophile macrostachya R.Br.	S(n)			+	+
Stirlingia latifolia (R.Br.) Steud. Blueboy	S(n)			+	+
Synaphaea sp.	S(n)			+	
LORANTHACEAE: Mistletoe family					
Nuytsia floribunda (Labill.) R.Br. Christmas tree	T(n)		+	+	

Name	Form & Origin	Habitat			
		P	T	B	H
POLYGONACEAE: Buckwheat family					
Emex australis Steinh. Double gee	H(i)		+		
CHENOPODIACEAE: Saltbush family					
Rhagodia baccata (Labill.) Moq.	S(n)		+		
AMARANTHACEAE: Amaranth family					
Ptilotus alopecuroideus F. Muell.	H(n)		+		
Ptilotus drummondii (Moq.) F. Muell.	H(n)		+		
GYROSTEMONACEAE:					
Tersonia brevipes Moq.	S(n)		+		
AIZOACEAE: Pigface family					
Carpobrotus aequilaterus (Haw.) N.E. Br. Chilean pigface	H(i)		+	+	
PORTULACACEAE: Purslane family					
Calandrinia corrigioloides F. Muell. ex Benth.	H(n)		+	+	
Calandrinia volubilis Benth.	H(n)		+	+	
CARYOPHYLLACEAE: Chickweed family					
Cerastium glomeratum Thuill. Mouse-ear chickweed	H(i)		+	+	
Petrorhagia sp. Proliferous pink	H(i)		+	+	
Silene gallica L. French catchfly	H(i)		+	+	+
RANUNCULACEAE: Buttercup family					
Clematis microphylla DC. Small-leaved clematis	C(n)		+	+	
Ranunculus colonorum Endl. ex al. Common buttercup	H(n)		+		
BRASSICACEAE: (Cruciferae) Cabbage family					
Heliophila pusilla L.	H(i)			+	
Raphanus raphanistrum L. Wild radish	H(i)		+	+	+
Sinapis arvensis L. *(Brassica sinapistrum)* Charlock	H(i)	+		+	+
DROSERACEAE: Sundew family					
Drosera erythrorhiza Lindl. Red-ink sundew	H(n)			+	
Drosera macrantha Endl.	C(n)			+	

Name	Form & Origin	Habitat			
		P	T	B	H
CRASSULACEAE: Stonecrop family					
Crassula colorata (Nees) Ostf. Dense stonecrop	H(n)		+	+	+
Crassula sp.	H(n)		+	+	
MIMOSACEAE: Wattle family					
Acacia saligna Wendl. Orange wattle	T(n)	+			
Acacia cyclops A. Cunn. ex G. Don	S(n)				+
Acacia pulchella R.Br. Prickly moses	S(n)		+	+	+
Acacia stenoptera Benth.	S(n)		+	+	
FABACEAE: (= Papilionaceae, Leguminosae) Pea family					
Bossiaea eriocarpa Benth.	S(n)			+	
Daviesia incrassata Sm.	S(n)			+	
Daviesia juncea Sm.	S(n)			+	
Gompholobium tomentosum Labill. Handsome wedge pea	S(n)			+	
Hardenbergia comptoniana Benth. Native wistaria	C(n)		+	+	+
Hovea trisperma Benth. Hovea	S(n)		+	+	
Isotropis cuneifolia (Sm.) Domin Lamb poison	H(n)			+	
Jacksonia furcellata (Bonpl.) DC.	S(n)		+		
Jacksonia sericea Benth.	S(n)		+		+
Jacksonia sternbergiana Hueg.	S(n)		+	+	+
Kennedia prostrata R.Br. Red runner; Creeping coral pea	C(n)		+	+	+
Lupinus cosentinii Guss. Sand-plain lupin	H(i)		+	+	+
Medicago sp. Medic	H(i)		+	+	+
Melilotus indicus (L.) All. Hexham scent	H(i)	+	+		
Oxylobium capitatum Benth.	S(n)			+	
Templetonia retusa (Vent.) R.Br. Cockies tongue, Bullock bush	S(n)		+		
Trifolium angustifolium L. Narrow-leaf clover	H(i)			+	
Trifolium fragiferum L. Strawberry clover	H(i)	+			
Vicia sativa L. Common vetch	H(i)	+	+	+	
GERANIACEAE: Storksbill family					
Erodium cicutarium (L.) Ait. Common crowfoot	H(i)			+	+

Name	Form & Origin	Habitat			
		P	T	B	H
Pelargonium capitatum (L.) Ait. Wild geranium	S(i)		+	+	+
OXALIDACEAE: Wood Sorrel family					
Oxalis corniculata L. Yellow wood sorrel	H(i)		+		
Oxalis pes-caprae L. Soursob	H(i)		+		
RUTACEAE: Boronia family					
Eriostemon spicatus A. Rich. Salt and pepper	S(n)			+	
EUPHORBIACEAE: Spurge family					
Adriana quadripartita Gaud. Rare bitter bush	S(n)	+	+		
Monotaxis sp.	S(n)			+	
Phyllanthus calycinus Labill. False boronia	S(n)		+	+	+
Ricinus communis L. Castor oil plant	S(i)	+		+	
Ricinocarpus sp. Wedding Bush	S(n)	+		+	
STACKHOUSIACEAE:					
Stackhousia huegelii Endl.	H(n)		+		
RHAMNACEAE: Buckthorn family					
Spyridium globulosum (Labill.) Benth.	S(n)	+	+		
Trymalium ledifolium Frezl.	S(n)		+	+	
DILLENIACEAE:					
Hibbertia subvaginata (Steud.) F. Muell. (=*H. glaberrima* (Steud.) Gilg.)	S(n)			+	
Hibbertia hypericoides (DC.) Benth. Guinea flower	S(n)		+	+	+
Hibbertia racemosa (Endl.) Gilg.	S(n)			+	
VIOLACEAE: Violet family					
Hybanthus calycinus (Steud.) F. Muell. Wild violet	H(n)			+	
THYMELIACEAE: Banjine family					
Pimelea rosea R.Br. Pink banjine, Native rose	S(n)		+		
Pimelea suaveolens (Endl.) Meisn. Yellow banjine	S(n)		+		
MYRTACEAE: Myrtle family					
Baeckea sp.	S(n)		+		+

Name	Form & Origin	Habitat			
		P	T	B	H
Calothamnus sanguineus Labill. Clawflower; Bottlebrush	S(n)		+		+
Chamelaucium uncinatum Schau. Geraldton wax plant	S(n)			+	
Eucalyptus calophylla R.Br. Marri	T(n)		+		
Eucalyptus gomphocephala DC. Tuart	T(n)	+	+	+	
Eucalyptus marginata Sm. Jarrah	T(n)		+	+	
Melaleuca acerosa Schau.	S(n)			+	
Melaleuca huegelii Endl. Chenille honey myrtle	S(n)		+		+
Melaleuca rhaphiophylla Schau. Swamp paperbark	T(n)	+			
Melaleuca ? teretifolia Endl.	S(n)	+			
APIACEAE: (= Umbelliferae) Carrot family					
Centella asiatica (L.) Urb. (= *Hydrocotyle asiatica* L.) Indian pennywort	H(n)	+			
Daucus glochidiatus Sieb. Native carrot	H(n)		+		
Eryngium pinnatifidum Bunge Blue devils	H(n)				+
Homalosciadium verticillatum (Turcz.) Domin	H(n)			+	
Trachymene pilosa Sm. Native parsnip	H(n)			+	
Xanthosia huegelii (Benth.) Steud.	H(n)			+	
EPACRIDACEAE: Australian heath family					
Astroloma pallidum R.Br.	S(n)			+	
Astroloma sp.	S(n)		+		
Conostephium pendulum Benth.	S(n)		+	+	
Leucopogon parviflorus (Andr.) Lindl.	S(n)			+	
Leucopogon propinquus R.Br.	S(n)		+		
PRIMULACEAE: Primula family					
Anagallis arvensis L. Scarlet pimpernel	H(i)	+			
Anagallis arvensis var. *caerulea* (L.) Gouan. Blue pimpernel	H(i)		+	+	+
Samolus repens (Forst.) Pers.	H(n)	+			
OLEACEAE: Olive family					
Olea europaea L. Olive	T(i)	+			

Name	Form & Origin	Habitat			
		P	T	B	H
LOGANIACEAE:					
Logania vaginalis (Labill.) F. Muell.	S(n)		+		
LAMIACEAE: (= Labiatae) Mint family					
Hemiandra pungens R.Br. Snake bush	S(n)				+
SOLANACEAE: Tomato family					
Anthocercis littorea Labill. Yellow-tail flower	S(n)		+		
Solanum sodomeum L. Apple of sodom	S(i)		+		
OROBANCHACEAE: Broom-rape family					
Orobanche australiana F. Muell. Australian broom-rape	H(n)				+
MYOPORACEAE: Poverty bush family					
Myoporum apiculatum A. DC.	S(n)		+		
Myoporum tetrandrum (Labill.) Domin	S(n)			+	
RUBIACEAE: Coffee family					
Opercularia vaginata Labill.	S(n)		+	+	+
LOBELIACEAE: Lobelia family					
Lobelia alata Labill. Angled lobelia	H(n)	+			
Lobelia tenuior R.Br. Slender lobelia	H(n)		+	+	+
GOODENIACEAE: Lechenaultia family					
Lechenaultia linarioides DC. Yellow lechenaultia	S(n)			+	+
Scaevola canescens Benth. Grey scaevola	S(n)				+
Scaevola paludosa R.Br. Marsh scaevola	S(n)		+	+	
Scaevola sp.	S(n)			+	+
STYLIDIACEAE: Trigger plant family					
Stylidium brunonianum Benth. Pink-fountain trigger plant	H(n)			+	
Stylidium repens R.Br.	H(n)			+	
ASTERACEAE: (= Compositae) Daisy family					
Arctotheca calendula (L.) Levyns Capeweed	H(i)		+	+	
Aster subulatus Michx. Bush starwort	H(i)	+			

Name	Form & Origin	Habitat			
		P	T	B	H
Cotula coronopifolia L. Water buttons	H(n)	+			
Craspedia sp. Billy buttons	H(n)		+		
Helichrysum cordatum DC. Heart-leaved everlasting	S(n)		+	+	
Hypochoeris glabra L. Smooth catsear	H(i)			+	+
Hypochoeris radicata L. Flatweed	H(i)	+			
Lagenifera stipitata (Labill.) Druce Common lagenifera	H(n)		+		
Osteospermum clandestinum (Less.) Norl.	H(i)			+	+
Podolepis gracilis (Lehm.) Grah. Slender podolepis	H(n)		+		
Podolepis nutans Steetz. Nodding podolepis	H(n)		+		+
Podotheca angustifolia (Labill.) Less. Sticky longheads	H(n)		+		+
Sonchus oleraceus L. emend. Gouan Common sowthistle	H(i)	+	+		
Ursinia anthemoides (R.Br.) Gaertn. Ursinia	H(i)		+	+	+
Waitzia podolepis (Gaudich.) Steetz.	H(n)			+	+

WESTERN AUSTRALIAN HERBARIUM RESEARCH NOTES

No. 2: 23-49

VEGETATION SURVEY OF FRANK HANN NATIONAL PARK

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ABSTRACT

Frank Hann National Park, east of Lake King, Western Australia (ca. 32°20'S lat., 120°22'E long.) has a woodland and shrubland flora characteristic of the Roe Botanical District but also has representatives of the Coolgardie District to the north and the Eyre District to the south. Seven vegetation formations, each with several subdivisions, are described. The vascular flora is listed and consists of 264 species in 47 families. The Myrtaceae (53 species) and Proteaceae (41 species) dominate the area.

INTRODUCTION

This is the first of a series of reports on the region covered by System 11 (Fig. 1) of the Report of the Conservation Through Reserves Committee (Anonymous, 1974). The region under study extends from about Grass Patch (33°14'S lat., 121°44'E long.) northwards to Wiluna (26°35'S lat., 120°14'E long.) and from about Bodallin (31°22'S lat., 118°51'E long.) eastwards to Zanthus (31°02'S lat., 123°34'E long.). The greater, northern part is within the Eremaean Botanical Province and the south western part within the South West Botanical Province (Beard, 1978).

Because the biological resources of the region as a whole are relatively poorly known, it was selected for detailed survey by a special committee coordinating biological surveys of the Department of Fisheries and Wildlife, the National Parks Authority, the Western Australian Herbarium, and the Western Australian Museum. Aspects of the flora, vegetation, and fauna are to be documented for the area.

The purpose of the interim reports is to make the results of the survey, which is expected to take several years, available as quickly as possible. At the conclusion of the entire survey, a summary report will be produced.

The selection of Frank Hann National Park as the starting point for the botanical portion of the survey was determined largely by consideration of

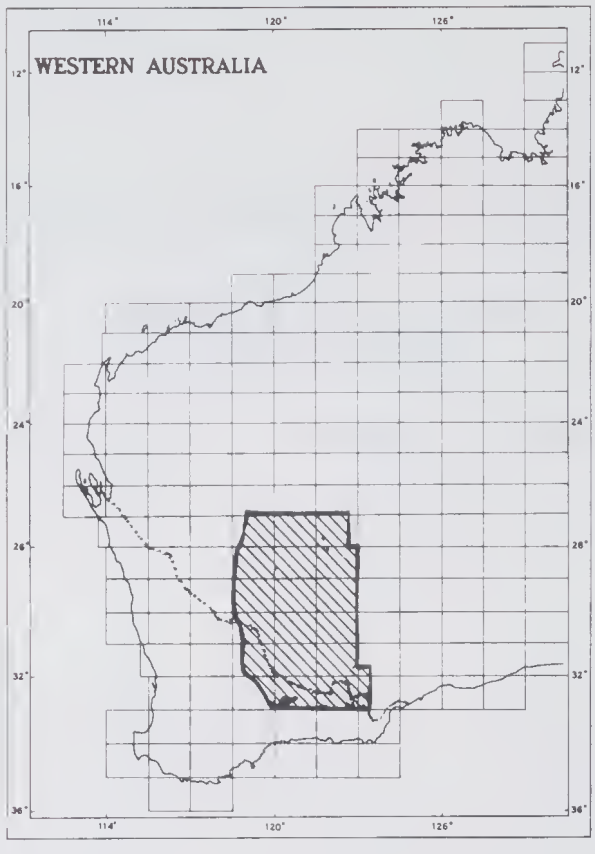

Fig. 1. Western Australia showing the location of the general survey area with Frank Hann National Park in the south west. The boundary between the Eremaean and South West Botanical Provinces is marked as a dotted line.

finance. The methods used were chosen to allow fulfilment of 3 immediate objectives: a) to produce a vegetation map, b) to describe the vegetation and flora, and c) to collect quantitative data on the vegetation for use in comparison with other areas to be surveyed in the general study.

Methods

Vegetation mapping was done by examination of aerial photographs, ground-checking the photo-patterns, then drawing a map combining field and photo information (Fig. 2). Aerial photos taken in different years permitted some of the fire history of the Park to be determined.

The vegetation was classified to Formations using the system of Muir (1977) so that comparison with his work, further west in the adjacent "wheatbelt", would be readily possible. For this classification, the height and canopy cover and growth form of the dominant and subordinate strata of plants were recorded.

Quantitative sampling of the vegetation was done at 25 sites, selected as representative of the patterns observed on aerial photographs. The sites chosen are all in the vicinity of the main road that traverses the southern areas of the Park (Fig. 3). The large northwestern sector of the Park was

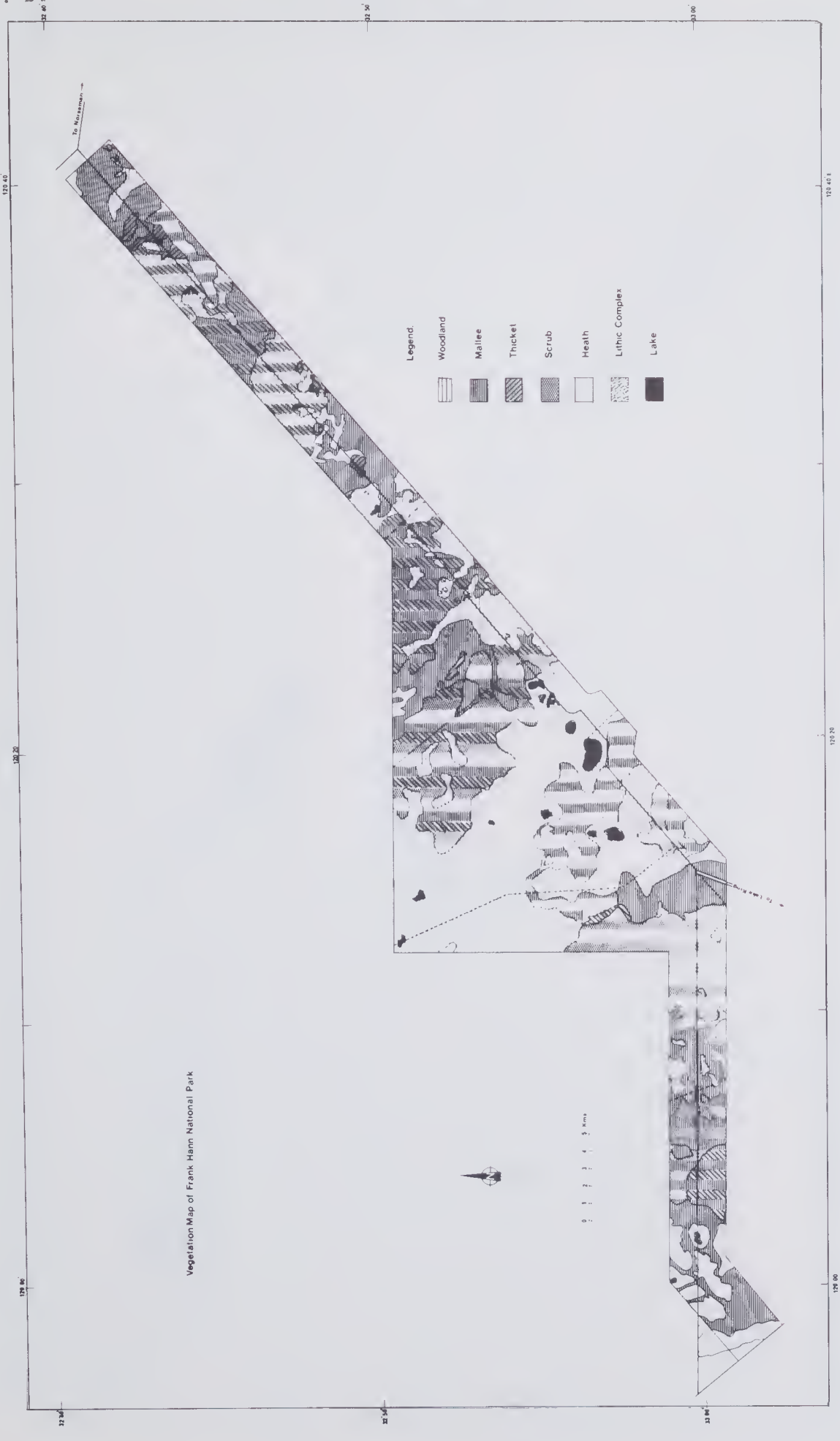

Fig. 2 A vegetation map of Frank Hann National Park.

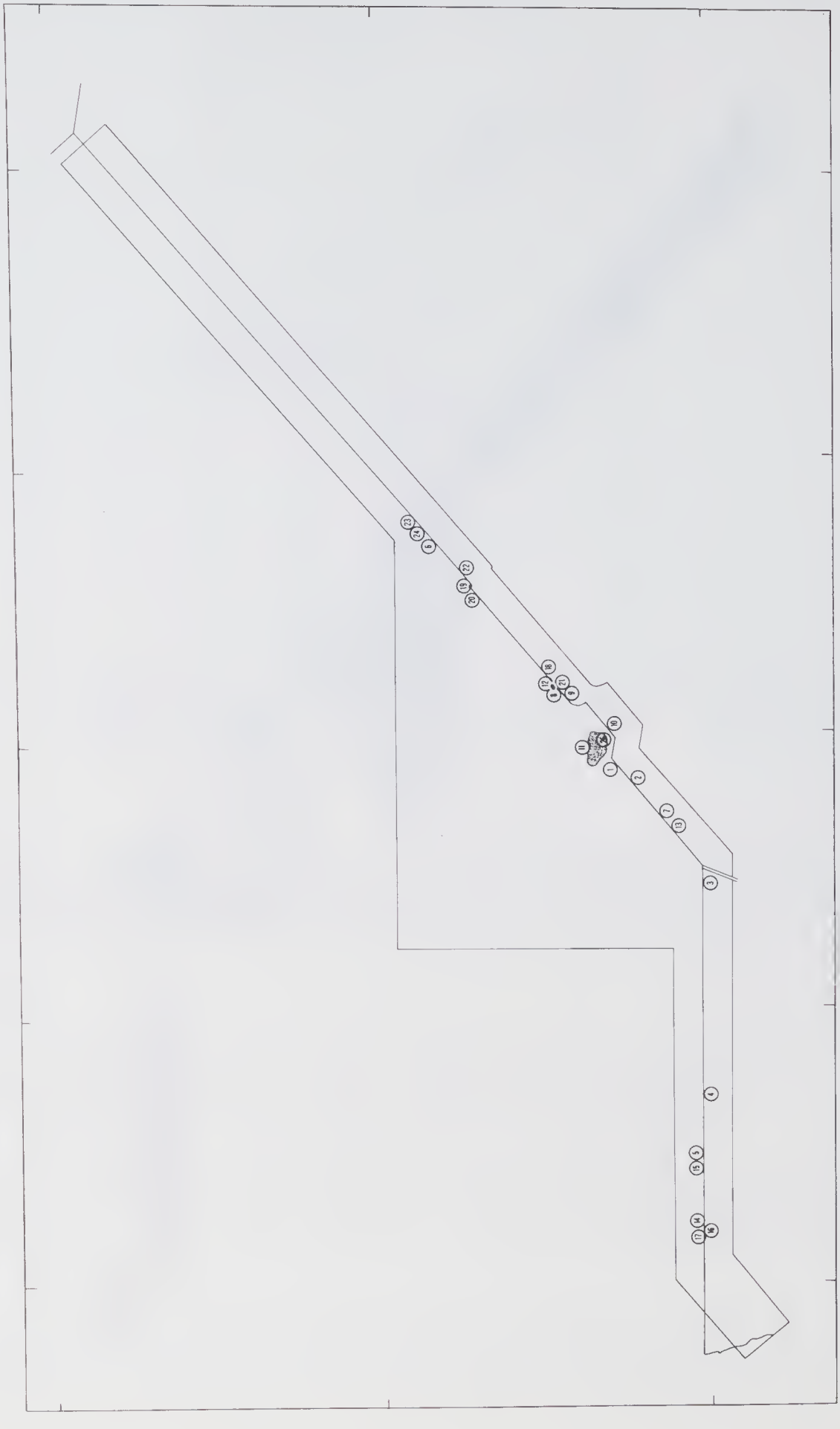

Fig. 3 The numbers and locations of sampled sites referred to in the text.

Contour Map of Frank Hann National Park showing locations of watercourses.
Contour Interval 20 m
Watercourse
To Lake King
Vermeulen Broad Tanks

Fig. 4 Elevational contours and water courses of Frank Hann National Park

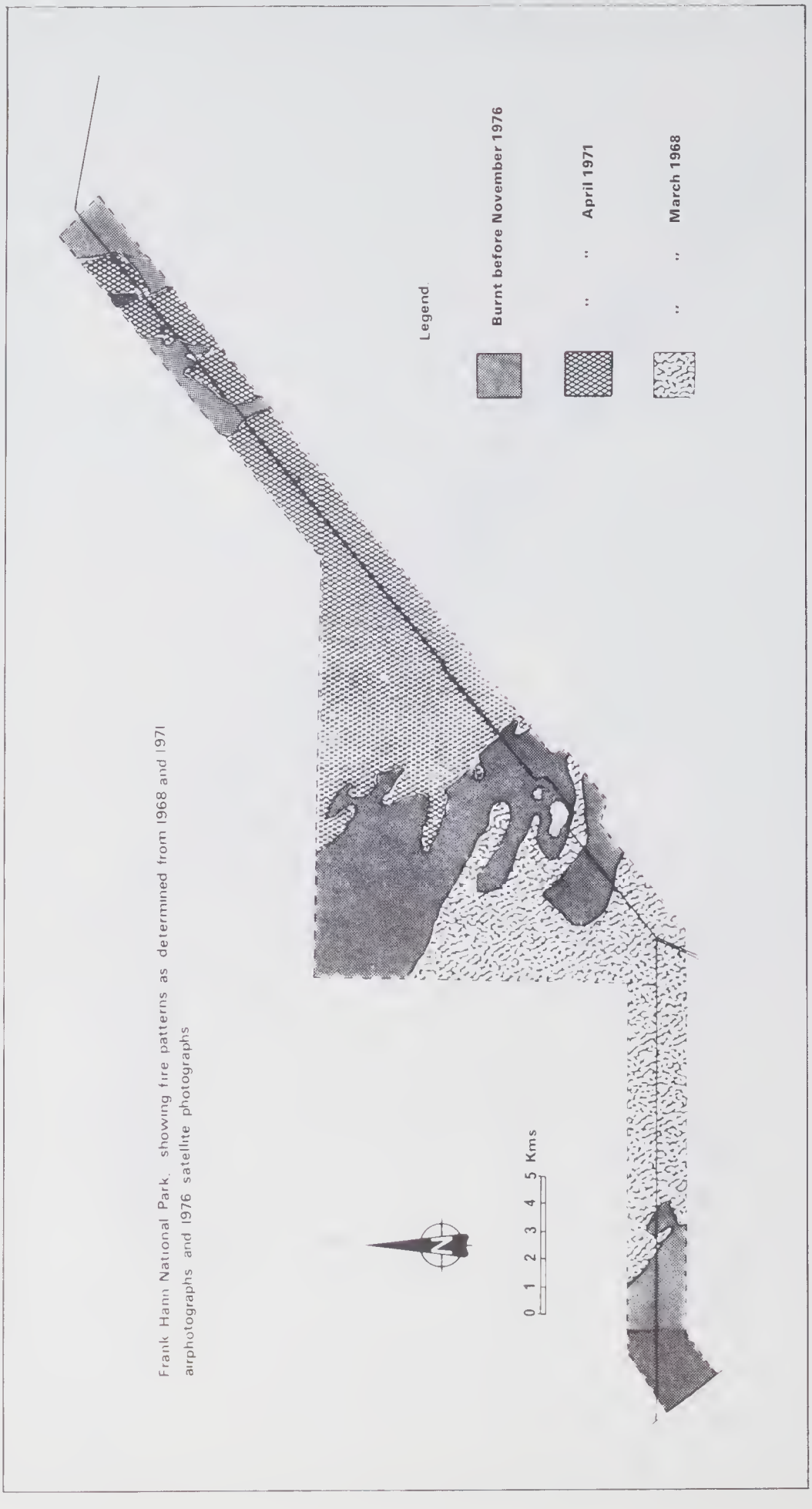
Frank Hann National Park, showing fire patterns as determined from 1968 and 1971 airphotographs and 1976 satellite photographs
Legend
Burnt before November 1976
" " April 1971
" " March 1968
N
0 1 2 3 4 5 Kms

Fig. 5. Fire history of Frank Hann National Park.

examined on the photos and by traverse and found not to contain vegetation not represented along the road. Thus for ease of access, sites near the road were chosen. At least two samples representing each kind of photo-pattern were collected in order to assess variation.

Sampling sites were located by pacing a randomly determined number of paces in towards the central area of each pattern unit. At the site, a square 10 m x 10 m plot was laid out. All species present within it were listed, and the height, canopy cover, vitality, and sociability (Mueller Dombois & Ellenberg, 1974) were noted for each. Species occurring nearby but not in the plot were recorded separately. The phenological state of the species, presence of dead plants, litter accummulation, and evidence of fire were recorded. A soil sample was collected, using an auger, to a depth of 1 m where possible. A voucher specimen for each plant species found in the Park was collected and was deposited in the Western Australian Herbarium (PERTH).

Location and History

The Frank Hann National Park (Reserve no. C 27023), ca. 50 km east of Lake King township and lying between lat. 32°41'S and 33°01'S and between long. 119°58'E and 120°43'E, lies in both the Dundas and Philips River Goldfields. Named after the surveyor and explorer, Frank Hann, who travelled the area in 1901, the Park has an area of ca. 49,877 ha and occupies a portion of the Ravensthorpe Shire on Western Australian Department of Lands and Surveys Lithograph Nos. 2831, 2931, 2932 and 3032.

The area was vacant Crown land until May 1970, when the reserve was gazetted and vested in the National Parks Board of Western Australia in trust for the purpose of National Park. On August 18, 1973, an additional area was added to the northeastern arm of the National Park increasing the area to almost twice that of the original (Lands and Surveys Misc. Plan 310).

Physiography and Basic Geology

Most of the geological substrate of the National Park is Quaternary marine and sedimentary rocks. The western extremity of the Park is situated on granites of the Yilgarn Block, the oldest of the Precambrian complexes of Western Australia (Clarke *et al.* 1967, Gower and Bunting 1976). Jennings and Mabutt (1971) discuss the overall physiography and drainage of this part of the State. The gentle, long slopes of the hills indicate erosion which has planed the original land surface to near flatness. Lateritic-capped "breakaway" complexes are present, but are smaller and less steep than in the western wheatbelt. They appear to represent residuals of the old peneplain (Mulcahy in Jennings and Mabutt 1971).

At the western extremity of the Park the high ground represents areas where granitic residuals are exposed whereas at the northeastern boundary the high ground overlies laterite of the old peneplain. The overall topography is characterized by gentle undulations varying between 280 and 420 m above sea level (Fig. 4). The Park, therefore, has an altitudinal range of 140 m. The watercourses of this Park are all intermittent, narrow and shallow. Some of these watercourses drain towards large lakes (mostly saline, but may be fresh after heavy rains) present in the Park. Other watercourses pass off the Park onto adjacent Crown Land. Salt accumulation

occurs in low lying areas, particularly around the lakes and along low-lying areas of the Lake King-Norseman Road.

Soil mapping of the region on a large scale has been done by Prescott (1931, 1933) and at a finer scale by Northcote *et al.* (1967). Within the Park, a variety of soil types can be recognized. The western section of the Park lies on duplex, alkaline, yellow soils which are quite variable in structure. They are characterized by hard-setting loamy soils with yellow, clayey subsoils. The soil of the middle section of the Park tends to have a gradational-texture profile of highly calcareous grey, brown or red loamy earths. The northeastern section has soils with a uniform-texture profile, consisting of sandy soil-matrices with ironstone gravels.

Fire History

No actual records of fires are available for the Park. However, from air photographs taken in March 1968 and April 1971 (made available by the Department of Lands and Surveys) and N.A.S.A. Land Satellite photographs, November 16, 1976, a number of fire patterns of varying ages can be seen. Most of the northeastern section of the Park was burnt by a fire just prior to November 1976 (Fig. 5). The middle section of the park was burnt by a fire that occurred between March 1968 and April 1971; however this fire did not enter the northeastern section. Air photographs of the western section of the park show fire scars that are evidence of fires previous to March 1968.

If the age of vegetation is related to the time since the last fire in that area, then the above-ground parts of the vegetation in the northeastern section of the park are ca. 2-7 years old; the middle section 7-10 years old and the western section older than 10 years.

Isolation

The National Park is contiguous with the virgin bush except for an area on the western boundary. Here an area adjacent to the Vermin fence has been cleared for agricultural use. The bush surrounding the remainder of the Park extends for over 100 km to the north and east and for ca. 30 km to the southwest. There are no firebreaks ploughed around the boundaries of the Park.

Climate

There are no climatic records for the Frank Hann National Park. Data are taken from the nearest three recording localities; Lake King, lat. 33° 06'S, long. 119°20'E (ca. 60 km W of the Park centre); Lake Grace, lat. 33° 06'S, long. 118°26'E (ca. 175 km W of the Park centre); and Norseman, lat. 32°16'S, long. 121°40'E (ca. 170 km NE of the Park centre). These data are presented in Table 1.

Flora and Vegetation

Because the area has been easily accessible only since the early 1960's, botanical collecting in Frank Hann National Park has been confined to recent years.

Table 1. Climatic data for Lake Grace, Lake King and Norseman.

	Lake Grace	Lake King	Norseman
Average annual rainfall (mm)	359	344	279
Average winter rainfall (May to Oct.)	254	128	152
Average summer rainfall (Nov. to April)	105	116	127
Evaporation, annual average (mm)	1,397	1,397	1,824
Average relative humidity (%) at 1500 hrs	35	NA	37
Agricultural growing season (months)	4.7	4.3	2.5
Break of growing season	Late April	Early May	Late May
Temperature (^{o}C)			
daily average*			
spring (Sept. to Nov.)	15	15	17
summer (Dec. to Feb.)	22	22	23
autumn (Mar. to May)	17	17	18
winter (Jun. to Aug.)	10	11	11
Mean max. for hottest month (Jan.)	32	31	33
Average number of days per annum where temperature exceeds 32^{o}C	53	NA	63.3
Average number of days per annum where temperature exceeds 38^{o}C	12	NA	15
Average minimum for coldest month (July)	5	5	5
Number of frosts per annum (below 2^{o}C)	19	NA	26.5
Average cloud cover per annum (eighths)			
9.00 am	3.9	NA	3.2
3.00 pm	4.1	NA	3.3
Average duration of sunshine (hours per day)	6.5	6.5	8.4
Wind			
Summer: Jan. 9.00 am direction	SE,E,NE	NA	E,NE,N
speed	50% 8 knots	NA	50% 6 knots
3.00 pm direction	SE,E,NE	NA	S,SE
speed	50% 8 knots	NA	50% 6 knots
Winter: July 9.00 am direction	W,NW,N	NA	W,NW
speed	50% 8 knots	NA	50% 8 knots
3.00 pm direction	SW,W,NW,N	NA	SW,W,NW
speed	50% 8 knots		60% 8 knots

NA = Not available
* = ½ (max. + min.)

The recorded flora totals 257 species in 112 genera of 46 families (Appendix 1). The principal families are Myrtaceae (53 species), Proteaceae (41), Mimosaceae (22), and Papilionaceae (12). The largest genera are *Acacia* (22 species), *Eucalyptus* (17) and *Melaleuca* (16). Collecting during summer through to mid winter would increase the known flora, especially of

Epacridaceae, which in southern heaths is usually well represented.

The Park lies towards the northern edge of the Roe Botanical District (Beard 1978). There is much interdigitation of vegetation representative of the Coolgardie District, itself an interzone between the South West and Eremaean Botanical Provinces. In the woodland, thicket and some mallee formations much of the flora of the Park is typical of this interzone and occurs here towards the southern limit of its range. In other mallee formations, as well as the heath and scrub, the species are mostly typical of southern heaths but lack those of coastal situations. Many of the heath species have extensive distributions to the west and south of the Park.

Several species are confined to the Park and its vicinity (within 100 km). These are *Acacia crassuloides*, *A. diaphyllodinea*, *Adenanthos gracilipes*, *Eucalyptus cerasiformis* and *E. deflexa*. An unnamed *Melaleuca* (Monk 332/333) is a previously unknown species. Gardner's (1952) vegetation map of Western Australia shows the area as Sclerophyllous Woodland, which, having regard to the scale of the map (1:8,000,000), is intended as a broad generalization. Beard visited the area in 1964 and mapped the following vegetation units: Salmon Gum woodland, mallee, scrub heath, heath, and thicket (Beard, 1968).

VEGETATION UNITS PRESENT IN FRANK HANN NATIONAL PARK

In the following discussion, formation and life form nomenclature follow that of Muir (1977).

Seven vegetation units have been delineated, although mosaics of two or more units occur (Fig. 3).

1. Woodland formations

The dominant life-form of the upper stratum was trees. The height of the upper stratum varied from 5-30 m and its canopy cover ranged from 5-50%. Mixed woodlands were more common than pure-stand woodlands although those dominated by Salmon Gum, *Eucalyptus salmonophloia*, occurred throughout low-lying areas of the park.

Dominant species of the upper stratum included *Eucalyptus diptera*, *E. eremophila*, *E. flocktoniae*, *E. gracilis*, *E. longicornis*, *E. pileata*, *E. salmonophloia* and *E. transcontinentalis*. *Melaleuca pauperiflora* occurred as a co-dominant in some of the woodlands. The understorey of the woodlands was dominated by *Melaleuca eleutherostachya*, *M. pauperiflora* and *M. uncinata*. The most common species occurring in the third stratum were *Boronia inornata*, *Cryptandra polyclada*, *C. tomentosa*, *Phebalium filifolium*, *P. lepidotum* and *P. tuberculosum*. In low-lying woodlands a ground cover of moss was present.

Generally the woodland formations were restricted to low-lying areas of the park, i.e. below 350 m altitude. The soil was a loamy clay, red, orange or light brown, with low forest and tall woodland occurring on the red loams while the low woodland occurred on the light brown, sandier soils. Litter accumulation varied between formations but the quantity was never considerable, the bulk of the litter input being from the eucalypts.

The following woodland formations were noted in the park; Forest, Low Forest A, Tall Woodland, Woodland, Low Woodland B, and Open Low Woodland A.

2. Mallee formations

The dominant life-form of the upper stratum was mallee, either of the shrub-form or the tree-form. The canopy cover varied from 2-70%. Tree mallees tended to occur adjacent to woodlands with an ecotone of both Tree Mallee and Low Woodland.

The dominant species of the upper stratum of the mallee formations were *Eucalyptus celastroides, E. eremophila, E. foecunda, E. longicornis E. micranthera* and *E. pileata*. The other strata of these formations were dominated by species of the Myrtaceae, Proteaceae and Mimosaceae. Mallee formations were restricted to areas that have sandy soil. Where the sand was very fine and white or yellow only the shrub-form mallee occurred as an emergent to 3 m tall. The amount of litter varied between formations, the older formations having the greatest accumulation. The bulk of the litter input was bark from the mallees.

The following mallee formations were noted in the park; Open Shrub Mallee, Very Open Shrub Mallee, and Very Open Tree Mallee. Some of the formations were regenerating after fire and therefore, when these formations have fully regenerated, one would also expect to find Shrub Mallee, Open Tree Mallee and Tree Mallee.

3. Thicket formations

The dominant life-form of the upper stratum was the shrub form. Structurally, the upper stratum had a canopy cover from 30-85% and the upper stratum was greater than 2 m. One or several species dominated the upper stratum. There were species of *Acacia, Casuarina* and Myrtaceae.

Thicket formations appeared to be restricted in their distribution to upland areas of the park (ca. 380 m above sea level), although thickets of *Melaleuca pauperiflora* occurred in low lying areas adjacent to *E. salmonophloia* and *E. transcontinentalis* woodlands. Thickets occurred on a variety of different soils throughout the park, with the exception that *M. pauperiflora* was restricted to the red clay that was subject to inundation in winter. Heavy litter accumulation was found in thickets, the major input coming from species of the upper stratum.

Thicket and Dense Thicket formations were noted in the park.

4. Scrub formations

The dominant life-form of the upper stratum was the shrub form. The height of the tallest stratum varied from less than 10 cm to in excess of 2 m and the canopy cover varied from 2-25%. When the canopy cover exceeds the critical value of 30% the formation may be described as a heath (see 5 below).

The upper stratum of the scrub formations was dominated by *Banksia media, Casuarina acutivalvis, Isopogon scabriusculus* and *Santalum acuminatum*. The second stratum was dominated by species of Myrtaceae and the third stratum was dominated by species of Cyperaceae and Poaceae.

Scrub formations, which occur on sand that varied in colour from white or light brown to yellow, were restricted to the upland areas of the park. Litter accumulation was very poor and concentrated about the base of larger plants. No large debris was present.

The following scrub formations were noted in the park; Scrub, Low Scrub A and Open Dwarf Scrub C. The Open Dwarf C formation was young regrowth after fire and therefore we would expect it to develop into Dwarf Scrub C and Low Scrub B formations when it has matured.

5. Heath formations

The dominant life form of the upper stratum was the shrub form. The height of the upper stratum did not exceed 2 m above ground level and the canopy cover varied from 30-45%. Emergents that occasionally occurred were *Banksia laevigata, B. media, Callitris preissii, C. roei, Casuarina acutivalvis* and *C. campestris*. The heath formations were composed mainly of species of the Myrtaceae and Proteaceae.

Heath formations were restricted to the upland areas of the park where the soil was of a sandy texture. They occurred on white or yellow sand, that contained a variable amount of laterite. Very little accumulation of litter occurred.

Low Heath C and Heath B were noted in the park. One of the Low Heath C formations was regenerating after fire, and therefore may grow into a Heath B formation with maturation.

6. Lithic complexes

The lithic complexes were mosaics of life-forms (including cryptogams, sedges, shrubs and trees) that were directly affected by their proximity to granite or other rock exposures. The lithic complexes included all species growing in crevices or soil-filled depressions and all annual species occupying rock pools. The rock pools were usually filled with water after rain and were fresh to taste. The soil was very shallow, dark brown and gritty. Species most commonly found on the lithic complexes were *Borya nitida, Calytrix brachyphylla, Drosera macrantha, Gahnia ancistrophylla, Lepidosperma resinosum, Neurachne alopecuroides* and *Melaleuca elliptica*, the latter being found in deeper soil at the edges of the exposed granite.

7. Salt complexes

All salt complexes noted in the National Park were salt lakes which differed between themselves in species composition. Lakes dominated by a new species of *Arthrocnemum* had a cracked and fissured, brown surface when dry. Soil samples were taken to a depth of 80 cm from the centre of one of these lakes. Soil from the top 10 cm was light brownish-

grey clay with a pH of 8.3 and a salt content (NaCl) of 0.24%. Clay from between 10-40 cm was of the same colour but had a salt content of 1.05% and a pH of 5.9. The lakes received rainfall run-off from a gravel road and the surrounding vegetation.

Lakes dominated by *Arthrocnemum lylei* had a smooth grey surface when dry. Soil samples to a depth of 40 cm were taken from the centre of one of these lakes. Because the clay was difficult to core, a precise depth of the clay sample cannot be given. The profile was uniform, being grey with a pH of 4.4 and a salt content (NaCl) of 2.48%. The run-off these lakes received was from the surrounding vegetation only.

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APPENDIX I

Site descriptions

1. Woodland formations

Plot 7
Key Description: Low Forest A over Open Low Scrub A over Dwarf Scrub C.

Stratification:
Stratum 1: All *Eucalyptus gracilis*, mature, 7.2-9 m tall, canopy cover 33-50%.
Stratum 2: *Melaleuca thyoides*, 1.8 m tall with very scattered distribution.
Stratum 3: *Boronia inornata, Daviesia acanthoclona, Lepidosperma resinosum* and *Grevillea huegelii*. 40-100 cm tall, canopy cover 10-30%.

Comments: No recent fires (within previous 10 years) have occured in this area.
Litter: covered 1-5% of plot.
Soil: 0-36 cm powdery loam;light brown/orange
36-40 cm light brown/yellow clay
below 40 cm kaolinized rock.

Plot 9
Key Description: Forest over Low Woodland B over Open Dwarf Scrub D over Very Open Mosses.

Stratification:
Stratum 1: *Eucalyptus transcontinentalis*, mature, 15-18 m tall, canopy cover 25-33%.
Stratum 2: *Eucalyptus eremophila, E. pileata* and *Melaleuca pauperiflora*, 4-6 m tall, canopy cover 25-33%.
Stratum 3: *Olearia meulleri*, 20 cm tall, canopy cover less than 1%.
Stratum 4: Moss, canopy cover less than 1%.

Outside plot: *Lepidosperma resinosum, Boronia inornata.*

Comments: No evidence of recent fire in this area.
Litter: Abundant, bark, leaves and large debris.
Soil: 0-1 cm dark brown,coarse sand mixed with litter
1-10 cm light brown fine sand
10-80 cm compacted clay white/light brown.

Plot 10
Key Description: Low Woodland B over Very Open Shrub Mallee over Open Dwarf Scrub D over Open Hummock Grass.

Stratification:
Stratum 1: *Eucalyptus flocktoniae*, 4-6 m tall, canopy cover 10-25%.
Stratum 2: *Eucalyptus* (Monk 124), 3 m tall, canopy cover 1-5%.
Stratum 3: *Melaleuca eleutherostachya*, *Choretrum pritzelii* (several other species present all with normal vitality), 30-60 cm tall, canopy cover 2-20%.
Stratum 4: Hummock and grass species, 20-40 cm tall, canopy cover 2-10%.

Comments: 1. Plot in regeneration state following fire.
2. On transitional ecotone between Shrub Mallee and Low Woodland A.
Litter: Sparse, but dead wood on ground has a cover of 12%.
Soil: 0-80 cm gradation from very fine, chocolate/orange sand to orange clay particles of medium size. Roots evident in top 10 cm.

Outside plot: *Eucalyptus gracilis*, *Bossiaea leptacantha*.

Plot 11
N.B. This plot is characterized by a species that was rooted outside of the plot boundaries, but the canopy of which overhung the plot.
Key Description: Open Low Woodland A over Open Low Scrub A over Open Dwarf Scrub D over Very Open Mosses.

Stratification:
Stratum 1: *Eucalyptus flocktoniae*, 5.5-7 m tall, canopy cover 5-10%.
Stratum 2: *Melaleuca uncinata* and *M. eleutherostachya*, 1.5-2 m tall, canopy cover 5-10%.
Stratum 3: Several species present, dominated by the family Myrtaceae, 20-40 cm tall, canopy cover 1-5%.
Stratum 4: Mosses of the genera *Bryum* and *Tortula*, canopy cover less than 1%.

Comments: No evidence of recent fires, although dead wood covered about 2% of the plot.
Soil: 0-20 cm very fine chocolate brown sand.
20-80 cm very fine light-brown/orange sand. Roots observed in top 20 cm.

Outside plot: *Acacia camptoclada*, *Eremophila decipiens* and *Callitris preissii*.

Plot 13
Key Description: Woodland over Open Low Scrub B over Open Dwarf Scrub D over over Open Dwarf Scrub D over Very Open Mosses.

Stratification:
Stratum 1: *Eucalyptus salmonophloia*, 26-30 m tall, canopy cover 25-33%
Stratum 2: *Cassia nemophila* and *Pittosporum phylliraeoides*, 1-1.5 m tall, canopy cover 5-10%.

Stratum 3: *Atriplex vesicaria*, *Eremophila glabra*, 30-40 cm tall, canopy cover 1-4%.
Stratum 4: *Ptilotus spathulatum* and *Sclerolaena diacantha*, 0-5 cm tall, canopy cover was very scattered and less than 1%.
Stratum 5: Lichens and mosses, very scattered with insignificant canopy cover.

Comments: No evidence of recent fire.
Litter: Abundant, leaves and large debris.
Soil: 0-24 cm powdery light brown loam
24-34 cm yellow/light brown clay
34-80 cm kaolinized clay/rock layer.

Outside plot: *Melaleuca cuticularis* to a height of 3.5 m.

2. Mallee formations

Plot 1
Key Description: Open shrub Mallee over Dwarf Scrub D over Open Dwarf Scrub D.

Stratification:
Stratum 1: Young *Eucalyptus eremophila*, 1-2 m tall, canopy cover 22%.
Stratum 2: Several species present including *Santalum acuminatum*, 30-50 cm tall, canopy cover 10%.
Stratum 3: Several species present, together with seedlings of species of other strata, 0-30 cm tall, canopy cover less than 2%.

Comments: This plot was burnt by a fire between 1968 and 1971 and is now regenerating.
Litter: None, bare ground covered 5%.
Soil: 0-26 cm very fine, chocolate/orange sand. Roots present in top 6 cm of profile.
26-80 cm kaolinized rock.

Plot 3
Key Description: Very Open Tree Mallee over Dwarf Scrub C over Dwarf Scrub D.

Stratification:
Stratum 1: Young *Eucalyptus celastroides*, 1 m tall, but dead branches projected above this to 6 m, canopy cover 1-5%.
Stratum 2: Dominated by Proteaceae and Myrtaceae, 40-70 cm tall, canopy cover 15-20%.
Stratum 3: Dominated by Mimosaceae, 0-40 cm tall, canopy cover 1-5%.

Comments: A recent fire burnt this area and when fully regenerated it would be an Open Tree Mallee.
Litter: None.
Soil: 0-15 cm chocolate-brown, fine loam
15-80 cm yellow clay.

Plot 6
Key Description: Very Open Shrub Mallee over Open Dwarf Scrub C over Open Hummock Grass.

Stratification:
Stratum 1: *Eucalyptus eremophila*, 2 m tall, canopy cover 1-5%.
Stratum 2: *Conospermum teretifolium* and *Hakea corymbosa* were emergent from this strata, several other species present, 30-100 cm tall, canopy cover 5-10%.
Stratum 3: *Loxocarya cinerea* dominated and seedlings of other species in higher strata were present, height 0-15 cm and canopy cover was insignificant (i.e. less than 1%).

Comments: A recent fire burnt this area and when regenerated it should be Open Shrub Mallee over Heath.
Litter: None.
Soil: 0-0.5 cm white sand
0.5-15 cm very fine, high-brown sand. Roots present in top 10 cm
15-70 cm very fine, white sand.

Plot 20
Key Description: Open Shrub Mallee over Open Dwarf Scrub C over Open Dwarf Scrub D.

Stratification:
Stratum 1: *Eucalyptus longicornis*, 1 m tall, canopy cover 10-25%.
Stratum 2: *Grevillea huegelii* and *Myoporum beckeri*, 50-60 cm tall, canopy cover 5-10%.
Stratum 3: *Cryptandra tomentosa, Cryptrandra glabriflora, Westringia rigida, Melaleuca cuneata* and three species of *Acacia*, 0-30 cm tall, canopy cover 1-5%.

Comments: Fire burnt this area between 1968 and 1971.
Litter: Very little.
Soil: 0-30 cm light-brown sand
30-80 cm yellow clay.

Plot 22
Key Description: Open Shrub Mallee over Open Dwarf Scrub D over Open Dwarf Scrub D.

Stratification:
Stratum 1: *Eucalyptus micranthera*, and *Exocarpus sparteus*, 1.7 m tall, canopy cover 10-25%.
Stratum 2: *Platysace maxwellii, Pimelea sulphurea* and an unnamed *Acacia*, 40-50 cm tall, canopy cover 1-5%.
Stratum 3: *Glischrocaryon roei, Goodenia watsonii, Melaleuca scabra, Lepidosperma resinosum, Gahnia polyphylla* and several other species, 0-30 cm tall, canopy cover 5-10%.

Comments: A fire burnt this area between 1968 and 1971.
Litter: Very small amount present in plot.
Soil: 0-0.5 cm white sand
0.5-10 cm light-brown sand
10-25 cm white/light brown sand
25-50 cm white clay
50-80 cm red/orange clay

3. Thicket formations

Plot 8
Key Description: Thicket over Very Open Dwarf Scrub over Very Open Mosses.

Stratification:
Stratum 1: Dominated by *Melaleuca pauperiflora*, 3-3.5 m tall with canopy cover of 30-35%.
Stratum 2: Only two species present, *Olearia muelleri* and *Stipa elegantissima*, both with scattered and insignificant cover.
Stratum 3: Very open mosses.

Comments: This was an almost pure stand of *Melaleuca pauperiflora* surrounded by woodland. The area was subject to inundation during winter.
Litter: Dead branches of *M. pauperiflora* covered about 1% of the plot.
Soil: 0-15 cm fine red clay
15-80 cm light brown clay with coarse white particles
80 cm compact clay.

Plot 12
Key Description: Dense Thicket over Dwarf Scrub C over Open Dwarf Scrub D over Very Open Herbs.

Stratification:
Stratum 1: *Acacia* (unnamed) and *Melaleuca uncinata*, 2.5-3.5 m tall, canopy cover 70-100%.
Stratum 2: *Baeckea maidenii*, *Micromyrtus drummondii*, *Thryptomene australis* and *Beyeria lechenaultii*, 60-100 cm tall, canopy cover 20-25%.
Stratum 3: *Conospermum distichum*, *Platysace effusa*, *Eriostemon rhomboideus* and *Conostephium drummondii*, 30-40 cm tall with insignificant cover.
Stratum 4: *Waitzea aurea* and *Helichrysum apiculatum*, 0-10 cm tall with insignificant cover.

Comments: There was no evidence of fire having affected this plot.
Litter: Fallen branches and leaves have accumulated.
Soil: 0-20 cm orange loam
20-80 cm orange/red clay.

Plot 18
Key Description: Thicket over Open Dwarf Scrub C over Open Dwarf Scrub D over Very Open Herbs.

Stratification:
Stratum 1: *Acacia* sp. and *Melaleuca uncinata*, 3-3.5 m tall, canopy cover 45-50%.
Stratum 2: *Micromyrtus drummondii*, 70 cm tall with 3-7% canopy cover.
Stratum 3: *Platysace maxwellii* and *Baeckea maidenii*, 40 cm tall with canopy cover of 5-10%.
Stratum 4: *Waitzea aurea* and several species of lichens, 0-10 cm tall, with very scattered distribution and insignificant cover.

Comments: No evidence of fire damage in this plot.
Litter: Covers about 70% of the plot, being *Acacia* branches and phyllodes.

Soil: 0-30 cm light-brown/orange loam
30-80 cm light-brown/orange loam.

Plot 24
Key Description: Thicket over Low Scrub B over Open Dwarf Srub D.

Stratification:
Stratum 1: *Casuarina acutivalvis*, 3 m tall, canopy cover 30-35%.
Stratum 2: *Micromyrtus drummondii* and *Melaleuca cordata*, 1-1.5 m tall, canopy cover of 20-25%.
Stratum 3: *Phebalium filifolium*, *Persoonia tortifolia*, *Hibbertia* sp. and *Acacia* sp., 25-70 cm tall, canopy cover 1-3%.

Comments: No fire has burnt in this area since 1968. There are dead plants of *Callitris preissii*, *Hakea falcata* and *Acacia* sp. in the plot.
Litter: From the above 3 species.
Soil: 0-80 cm very dry, powdery loam with gravel with large pebbles at low end of the profile.

4. Heath formations

Plot 5
Key Description: Low Heath C over Open Dwarf Scrub D.

Stratification:
Stratum 1: Several species present, dominated by Myrtaceae and Proteaceae, 30-60 cm tall, canopy cover 25-33%.
Stratum 2: Several species present, dominated by Myrtaceae and Proteaceae, 0-30 cm tall, canopy cover 1-5%.

Comments: 1. A fire burnt in this area between 1968 and 1971.
2. *Casuarina campestris*, *Banksia laevigata* and *Callitris preissii* occurred outside plot.
Litter: None.
Soil: 0-40 cm sand and gravel
40-80 cm compacted gravel.

Plot 14
Key Description: Low Heath C over Low Heath D over Open Dwarf Scrub D over Very Open Herbs.

Stratification:
Stratum 1: *Hakea falcata* and *Isopogon scabriusculus*, 50-70 cm tall, canopy cover 30-35%.
Stratum 2: Dominated by *Verticordia roei*, *Verticordia chrysantha* and *Beaufortia micrantha*, several other species present, 30-50 cm tall, canopy cover 40-45%.
Stratum 3: Dominated by *Calytrix brachyphylla*, several other species present, 20-30 cm tall, canopy cover 5-10%.
Stratum 4: *Stylidium breviscapum*, *S. squamellosum*, *Conostylis petrophiloides* and several other species, 0-20 cm tall, canopy cover insignificant.

Litter: Dead plants of *Isopogon scabriusculis*, *Verticordia roei* and *Beaufortia micrantha* are contributing most to litter accumulation.
Soil: 0-15 cm powdery, light-brown gravel
15-80 cm compacted clay/gravel.

Plot 15
Key Description: Heath B over Open Dwarf Scrub D over Open Dwarf Scrub D.

Stratification:
Stratum 1: *Banksia media*, *Casuarina corniculata*, *Pimelia suaveolens* and *Grevillea* sp., 60-80 cm tall, canopy cover 35-40%.
Stratum 2: Dominated by the Proteaceae and Myrtaceae, 25-40 cm tall, canopy cover 3-5%.
Stratum 3: Dominated by Myrtaceae and Cyperaceae, 0-25 cm tall, canopy cover 3-5%.

Comments: A fire burnt this area between 1968 and 1971.
Litter: None.
Soil: 0-38 cm powdery, brown loam and gravel
38-80 cm dark-orange gravel/clay.

5. Scrub formations

Plot 4
Key Description: Open Dwarf Scrub C over Open Dwarf Scrub D over Open Hummock Grass.

Stratification:
Stratum 1: Dominated by *Casuarina acutivalvis*, 60 cm tall, canopy cover 1-5%.
Stratum 2: Several species present dominated by Myrtaceae, 20-40 cm tall, canopy cover 5-10%.
Stratum 3: Dominated by *Borya nitida*, 0-15 cm tall, canopy cover 1-5%.

Comments: Although this plot was designated Open Dwarf Scrub C it will probably grow into a thicket when mature.
Litter: None.
Soil: 0-20 cm loamy gravel
20-80 cm gravel with clay.

Plot 21
Key Description: Scrub over Low Scrub A over Open Dwarf Scrub D over Very Open Low Grass.

Stratification:
Stratum 1: *Santalum acuminatum*, *Melaleuca uncinata*, *Eucalyptus cylindriflora* and *Melaleuca acuminata*, 2.5-3.5 m tall, canopy cover 25-30%.
Stratum 2: *Micromyrtus drummondii*, *Baeckea maidenii*, *Acacia* sp. and *Lepidosperma resinosum*, 1-1.5 m tall, canopy cover 25-30%
Stratum 3: *Acacia multispicata* and *Grevillea huegelii*, 40-50 cm tall, canopy cover insignificant.
Stratum 4: *Danthonia setacea* and *Stipa elegantissima*, 0-30 cm tall, canopy cover insignificant.

Comments: 1. No evidence of fire in this area.
2. Area receives water from runoff from gravel road.
Litter: Small amount.
Soil: 0-1 cm wet clay layer
1-5 cm light-brown clay
5-80 cm dark-brown clay.

Plot 23
Key Description: Low Scrub A over Open Scrub A over Dwarf Scrub C over Open Dwarf Scrub D

Stratification:
Stratum 1: *Santalum acuminatum*, *Melaleuca densa* and *Casuarina acutivalvis*, 2-2.5 m tall, canopy cover 20-25%.
Stratum 2: *Melaleuca uncinata*, *Hakea falcata*, *Melaleuca scabra* and *Eucalyptus pileata*, 1-2 m tall, canopy cover 5-10%.
Stratum 3: Dominated by *Lepidosperma resinosum*, 40-60 cm tall, canopy cover 20-25%.
Stratum 4: Several species of the Myrtaceae present, stratum 15-25 cm tall, canopy cover 1-3%.

Comments: *Callitris preissii* grows outside plot.
Litter: Accumulated since last fire (between 1968 and 1971).
Soil: 0-10 cm powdery, light-brown sand with gravel
10-50 cm powdery, light-brown sand with large pieces of gravel
50-80 cm light-brown sand with yellow clay.

6. Lithic complexes

Plot 16
Key Description: Dwarf Scrub C over Open Dwarf Scrub D over Mid-Dense Hummock Grass.

Stratification:
Stratum 1: *Thryptomene australis*, 1 m tall, canopy cover 20-25%.
Stratum 2: *Calytrix brachyphylla*, *Melaleuca elliptica*, and *Dodonaea microzyga*, 20-30 cm tall, canopy cover 5-10%.
Stratum 3: Dominated by *Borya nitida*, 5-15 cm tall, canopy cover 50-55%.

Comments: No fire damage.
Litter: Very small amount.
Soil: 0-19 cm dark-brown, gritty soil (depth variable).
19 cm solid granite.

Plot 17
Key Description: Heath A over Open Low Sedges over Very Open Mat Plants.

Stratification:
Stratum 1: *Melaleuca elliptica*, 1.5 m tall, canopy cover 45-50%.
Stratum 2: *Lepidosperma resinosum*, *Gahnia ancistrophylla*, and *Spartochloa scirpoidea*, 30-50 cm tall, canopy cover 15-20%.
Stratum 3: Dominated by *Borya nitida*, 10-25 cm tall, canopy cover 5-10%.

Comments: No fire damage.

Litter: None.
Soil: 0-38 cm down-brown, gritty soil.
38-43 cm dark-brown clay.
43 cm solid granite.

7. Saline complexes

Plot 19
Key Description: Dwarf Scrub D

Stratification:
Only 1 stratum was noted. *Arthrocnemum* sp. grew as a pure population, stratum 0-15 cm tall, canopy cover 20-25% at sample point.

Comments: The lake had a large run-off from a gravel road.
Litter: None.
Soil: When dry the lake surface had a cracked surface.
0-10 cm pH = 8.3 ; % NaCl = 0.24, colour 2.5 Y 6/2 light-brown clay
10-40 cm , pH = 5.9 % NaCl = 1.05; colour 2.5 Y 6/2 light-brown clay

Plot 25
Key Description: Open Dwarf Scrub D

Stratification:
Only 1 stratum was noted: *Arthrocnemum lylei* grew as a pure population, 0-30 cm tall, canopy cover 5-10%.

Comments: The plot was in a large salt lake surrounded by wind-blown dunes.
Litter: None.
Soil: 0-40 cm ; pH = 4.4 ; % NaCl - 2.48 ; colour 5 Y 5/1 grey clay.

APPENDIX 11 SPECIES LIST OF FRANK HANN NATIONAL PARK

All specimens are lodged with the Western Australian Herbarium (PERTH). Collecting numbers of D. Monk (and R.J. Cranfield (RJC)) are given for taxa that are indeterminate or doubtful.

Species	Coll. No.	Family
Acacia bidentata Benth.		Mimosaceae
A. brachyclada W.V. Fitzg.		"
A. camptoclada C. Andrews		"
A. crassuloides Maslin		"
A. densiflora A. Morrison		"
A. diaphyllodinea Maslin		"
A. eremophila W.V. Fitzg.		"
A. erinacea Benth.		"
A. harveyi Benth.		"

Species	Coll. No.	Family
Acacia ixiophylla Benth.		Mimosaceae
A. ? jutsonii Maiden	060	"
A. merrallii F. Muell.		"
A. multispicata Benth.		"
A. nodiflora var. *ferox* E. Pritzel		"
A. poliochroa E. Pritzel		"
A. spinosissima Benth.		"
A. unifissilis A.B. Court		"
A. sp. *(sulcata-nitidula group)*	322	"
A. sp.	473	"
A. sp.	234	"
A. sp.	347	"
A. indet.	053	"
A. indet.	410	"
Adenanthos argyraeus Diels		Proteaceae
A. cuneatus Labill.		"
A. gracilipes A.S. George		"
Alyxia buxifolia R.Br.		Apocynaceae
Anthocercis microphylla F. Muell.		Solanaceae
A. aromatica C.A. Gardn.		"
Arthrocnemum lylei (Ewart & White) J.M. Black		Chenopodiaceae
Arthrocnmum sp.	482	"
Atriplex vesicaria (Ewart) J.M. Black		"
Baeckea fumana (Schau.) F. Muell.		Myrtaceae
B. maidenii Ewart & White		"
Banksia elderana F. Muell.		Proteaceae
B. laevigata Meisn. subsp. *fuscolutea* George		"
B. media R.Br.		"
B. violacea C.A. Gardn.		"
Beaufortia micrantha Schau.		Myrtaceae
B. schaueri Preiss		"
Beyeria lechenaultii (DC.) Baill.		Euphorbiaceae
Billardiera coriacea Benth.		Pittosporaceae
Boronia crassifolia Benth.		Rutaceae
B. inornata Turcz.		"
B. ramosa (Lindl.) Benth.		"
B. ternata Endl. var. *ternata*		"
Borya nitida Labill.		Liliaceae
Bossiaea leptacantha E. Pritzel		Papilionaceae
B. rufa R.Br. var. *foliosa* Benth.		"
Brachycome ciliaris (Labill.) Less.		Asteraceae
Brachyloma concolor F. Muell.		Epacridaceae
Brachysema daviesioides (Turcz.) Benth.		Papilionaceae
Calectasia cyanea R.Br.		Xanthorrhoeaceae
Callitris canescens (Parl.) S.T. Blake		Cupressaceae
C. preissii Miq. subsp. *verrucosa* (A. Cunn. ex Endl.) J. Garden		"
C. roei (Endl.) F. Muell.		"
Calothamnus quadrifidus R.Br.		Myrtaceae
Calytrix brachyphylla Turcz.		"
C. affin. *fraseri* A. Cunn.		"
Cassia nemophila A. Cunn. ex Vog.		Caesalpiniaceae
Casuarina acutivalvis F. Muell.		Casuarinaceae
C. campestris Diels		"
C. corniculata F. Muell.		"

Species	Coll. No.	Family
Casuarina humilis Otto. and Dietr.		Casuarinaceae
C. microstachya Miq.		"
Chamelaucium ciliatum Desf.		Myrtaceae
C. megalopetalum (Benth.) F. Muell.		"
Choretrum pritzelii Diels		Santalaceae
Chorizema aciculare (DC.) C.A. Gardn.		"
Codonocarpus cotinifolius (Desf.) F. Muell.		Phytolaccaceae
Comesperma calymega Labill.		Polygalaceae
C. volubile Labill.		"
Conospermum distichum R.Br.		Proteaceae
C. teretifolium R.Br.		"
Conostephium drummondii (Stschegl.) C.A. Gardn.		Epacridaceae
C. affin. *roei* Benth.		"
Conostylis androstemma Lindl. subsp. *argentea* J.W. Green		Haemodoraceae
C. petrophiloides F. Muell.		"
Coopernookia strophiolata (F. Muell.) Carolin		Goodeniaceae
Cryptandra glabriflora Benth.		Rhamnaceae
C. polyclada Diels		"
C. pungens Steud.		"
C. tomentosa Lindl.		"
Dampiera eriocephala De Vriese		Goodeniaceae
D. lavandulacea Lindl.		"
D. sacculata (F. Muell.) Benth.		"
D. sp.	401	"
Danthonia setacea R.Br.		Poaceae
Darwinia sp.	422,004	Myrtaceae
Daviesia acanthoclona F. Muell.		Papilionaceae
D. uniflora Herbert		"
D. sp.	401	"
Dianella revoluta R.Br.		Liliaceae
Dodonaea bursariifolia Behr & F. Muell.		Sapindaceae
D. microzyga F. Muell.		"
Drosera macrantha Endl.		Droseraceae
Dryandra erythroclada C.A. Gardn.		Proteaceae
D. ferruginea Kipp		"
D. sp.	305,277	"
Drummondita hasselli F. Muell.		Rutaceae
Duboisia hopwoodii (F. Muell.) F. Muell.		Solanaceae
Enchylaena tomentosa R.Br.		Chenopodiaceae
Eremophila calhorrhabdos Diels		Myoporaceae
E. decipiens Ostf.		"
E. dichroantha F. Muell.		"
E. glabra (R.Br.) Ostf.		"
E. pachyphylla Diels		"
Eriostemon gardneri P.G. Wils.		Rutaceae
E. rhomboideus P.G. Wils.		"
Eucalyptus celastroides Turcz.		Myrtaceae
E. cerasiformis Brooker & Blaxell		"
E. cylindriflora Maiden & Blakely		"
E. deflexa Brooker		"
E. diptera C.R. Andrews		"
E. eremophila (Diels) Maiden		"

Species	Coll. No.	Family
Eucalyptus flocktoniae Maiden		Myrtaceae
E. foecunda Schau.		"
E. gracilis F. Muell.		"
E. incrassata Labill.		"
E. longicornis F. Muell.		"
E. micranthera Benth.		"
E. occidentalis Endl.		"
E. pileata Blakely		"
E. redunca Schau.		"
E. salmonophloia F. Muell.		"
E. transcontinentalis Maiden		"
Exocarpos aphyllus R.Br.		Santalaceae
E. sparteus R.Br.		"
Gahnia ancistrophylla Benth.		Cyperaceae
G. lanigera (R.Br.) Benth.		"
G. polyphylla Benth.		"
Gastrolobium reticulatum (Meisn.) Benth.		Papilionaceae
G. stenophyllum Turcz.		"
Glischrocaryon roei Endl.		Haloragaceae
Goodenia affinis De Vriese		Goodeniaceae
G. incana R.Br.		"
G. watsonii F. Muell. & Tate		"
Grevillea acuaria (F. Muell.) Benth.		Proteaceae
G. concinna R.Br.		"
G. didymobotrya (Endl.) Meisn.		"
G. eriostachya Lindl.		"
G. extorris S. Moore		"
G. huegelii Meisn.		"
G. aff. *hookerana* Meisn.		"
G. oncogyne Diels		"
G. pauciflora R.Br.		"
G. sp.	248	"
Hakea corymbosa R.Br.		"
H. crassifolia Meisn.		"
H. dolichostyla Diels		"
H. falcata R.Br.		"
H. incrassata R.Br.		"
H. laurina R.Br.		"
H. lissocarpha R.Br.		"
H. multilineata Meisn.		"
H. scoparia Meisn.		"
Halgania andromedifolia F. Muell.		Boraginaceae
H. integerrima Endl.		"
Helichrysum apiculatum (Labill.) DC.		Asteraceae
H. lepidophylla (Steetz.) Benth.		"
Hibbertia exasperata (Steud.) Briq.		Dilleniaceae
H. aff. *uncinata* (Benth.) F. Muell.	326	"
H. sp.	156	"
H. sp.	271	"
Hybanthus epacroides (C.A. Gardn.) Melchior.		Violaceae
H. floribundum (Walp.) F. Muell.		"
Isopogon attenuatus R.Br.		Proteaceae
I. scabriusculus Meisn.		"

Species	Coll. No.	Family
Isopogon teretifolius R.Br.		Proteaceae
I. sp.	403	"
Lasiopetalum rosmarinifolium (Turcz.) Benth.		Sterculiaceae
Lepidosperma drummondii Benth.		Cyperaceae
L. resinosum (Nees) Benth.		"
Leptospermum erubescens Schau.		Myrtaceae
Leucopogon aff. *gracillimus* DC.	253	Epacridaceae
L. conostephioides DC.		"
L. fimbriatus Stschegl.		"
Lomandra effusa (Lindl.) Ewart		Xanthorrhoeaceae
Loxocarya cinerea R.Br.		Restionaceae
Lysinema ciliatum R.Br. var. *ericoides* Ostf.		Epacridaceae
Maireana enchylaenoides (F. Muell.) P.G. Wilson		Chenopodiaceae
Melaleuca acuminata F. Muell.		Myrtaceae
M. cordata Turcz.		"
M. cuneata Turcz.		"
M. cuticularis Labill.		"
M. densa R.Br.		"
M. eleutherostachya F. Muell.		"
M. elliptica Labill.		"
M. leptospermoides Schau.		"
M. pauperiflora F. Muell.		"
M. pentagona Labill.		"
M. scabra R.Br.		"
M. thyoides Turcz.		"
M. uncinata R.Br.		"
M. undulata Benth.		"
M. sp.	413	"
M. sp.	322/333	"
Microcorys aff. *tenuifolia* Benth.	346	Lamiaceae
Microcybe multiflora Turcz.		Rutaceae
Micromyrtus drummondii Benth.		Myrtaceae
Mirbelia spinosa Benth.		Papilionaceae
Monotaxis grandiflora Endl.		Euphorbiaceae
Muehlenbeckia adpressum (Labill.) Meisn.		Polygonaceae
Myoporum beckeri F. Muell. ex Benth.		Myoporaceae
Neurachne alopecuroides R.Br.		Poaceae
Olax benthamiana Miq.		Olacaceae
Olearia adenolasia F. Muell.		Asteraceae
O. muelleri (Sond.) Benth.		"
O. ramosissima Benth.		"
Opercularia vaginata Labill.		Rubiaceae
Oxylobium reticulatum Meisn.		Papilionaceae
Pelargonium sp.	RJC 803	Geraniaceae
Persoonia tortifolia Meisn.		Proteaceae
P. sp.	173	"
Petrophile ericifolia R.Br.		"
P. seminuda Lindl.		"
P. trifida R.Br.		"
Phebalium filifolium Turcz.		Rutaceae
P. lepidotum (Turcz.) P.G. Wilson		"
P. tuberculosum (F. Muell.) Benth.		"
Pimelea suaveolens (Endl.) Meisn.		Thymelaeaceae
P. aff. *imbricata* R.Br.	186	"

Species	Coll. No.	Family
Pimelea sulphurea Meisn.		Thymelaeaceae
Pittosporum phylliraeoides DC.		Pittosporaceae
Pityrodia terminalis (Lindl.) A.S. George		Chloanthaceae
Platysace effusa (Turcz.) Norman		Apiaceae
P. maxwellii (F. Muell.) Norman		"
Podolepis lessonii (Cass.) Benth.		Asteraceae
Prasophyllum sargentii (Nicholls) A.S. George		Orchidaceae
Prostanthera microphylla (R.Br.) A. Cunn.		Lamiaceae
P. sp.	397	"
Psammomoya choretroides (F. Muell.) Diels & Loes.		Celastraceae
Ptilotus spathulatus (R.Br.) Poir.		Amarantaceae
Pultenaea conferta Benth.		Papilionaceae
P. dasyphylla (Turcz.) C.A. Gardn.		"
Santalum acuminatum (R.Br.) DC.		Santalaceae
Schoenus globifer Nees		Cyperaceae
S. subaphyllus Boeck		"
Sclerolaena diacantha (Nees) Benth.		Apiaceae
Solanum hystrix R.Br.		Solanaceae
Spartochloa scirpoidea (Steud.) C.E. Hubbard		Poaceae
Spyridium sp.	090	Rhamnaceae
Stackhousia brunonis Benth.		Stackhousiaceae
S. huegelii Endl.		"
Stipa elegantissima Labill.		Poaceae
S. scabra Lindl.		"
Stylidium breviscapum R.Br.		Stylidiaceae
S. squamellosum DC.		"
Stypandra imbricata R.Br.		Liliaceae
Synaphea sp.	023,289	Proteaceae
Thomasia sarotes Turcz.		Sterculiaceae
Thryptomene appressa C. Andrews		Myrtaceae
T. australis Endl.		"
T. kochii E. Pritzel		"
Verticordia chrysantha Endl.		"
V. humilis Benth.		"
V. insignis Endl.		"
V. picta Endl.		"
V. roei Endl.		"
Vittadinia sp.	203	Asteraceae
Waitzia aurea (Benth.) Steetz.		"
Westringia affin. *dampieri* R.Br.		Lamiaceae
W. rigida R.Br.		"
Zygophyllum glaucum F. Muell.		Zygophyllaceae

Total Numbers

species	genera	families
264	113	47

84109/3/79—1,200—L/2788

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